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WHIBLEY'S REVOLVING-TABLE BANDSAW MACHINE.

FOR CUTTING HANDRAIL WREATHS, CIRCLE-UPON-CIRCLE RAILS, DOVETAILS, AND OBLIQUE CUTS OF EVERY DESCRIPTION.

BY THE INVENTOR.

THE MACHINE ITSELF: ITS PECULIARITIES AND CHARACTERISTICS.

ABOUT three years ago, whilst discussing with a fellow-workman various matters pertaining to the principles and practice of handrailing, I was asked if I thought it within the range of possibilities to cut a squared handrail wreath direct from the plank by means of a bandsaw machine. This question set me thinking, and suggested possibilities not previously thought of. A careful examination of the conditions to be complied with led me to see that though handrail wreaths, or rather forms

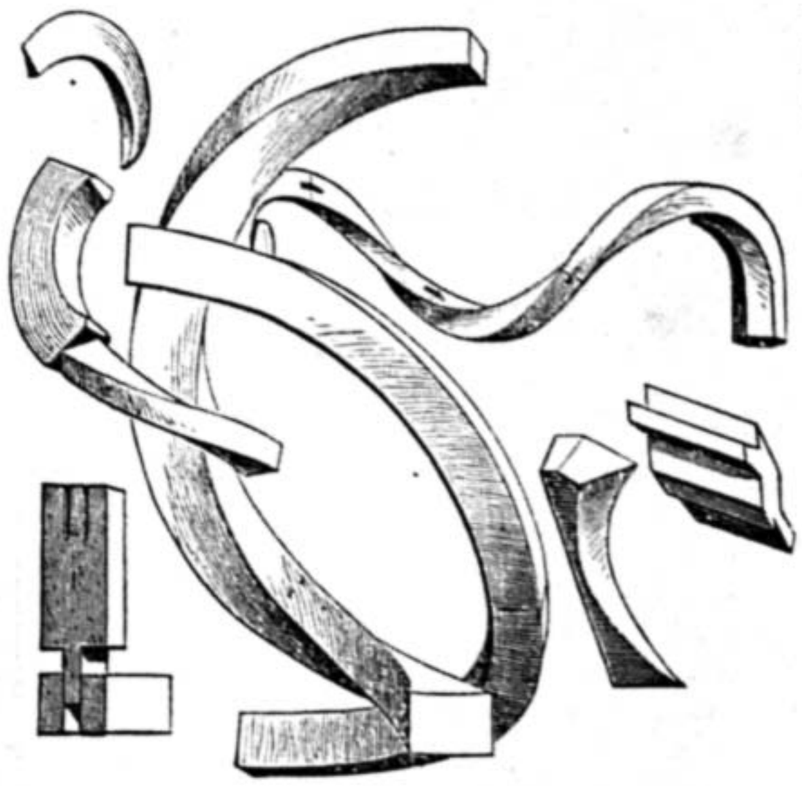

Fig. 3.- Group of Pieces cut by Machine.

possessing the elementary properties of handrail wreaths, might within very narrow limits of possibilities be produced upon the table of an ordinary bandsaw machine, by the aid of auxiliary appliances designed for that purpose and for use upon the table, yet the conditions were obviously such as to render these machines practically useless for any such purpose; and hence it was that such work was invariably done by hand labour at the bench. What was required was a machine with a table that could be canted to the pitch angle of plank from which the rail was to be cut (usually a very steep incline), and while so canted, or in any other position, turned freely around the saw; means being also provided for suitably controlling the movements upon the table of the material to be cut. That such was practically possible was soon placed beyond doubt. A jigger or fretsaw machine was made to these conditions, using for that purpose the blade of my bowsaw connected

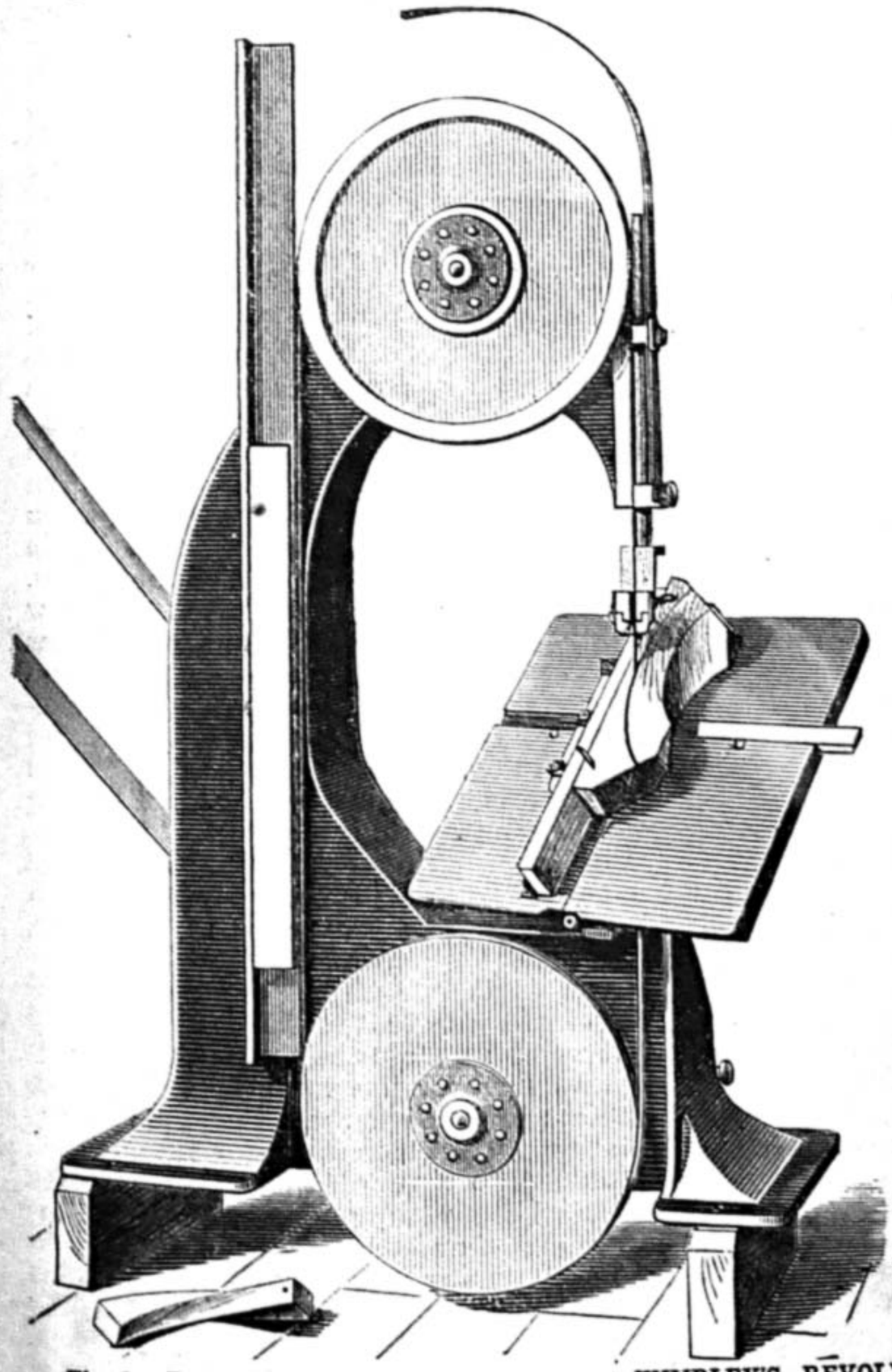

Fig. 1.—Front View.

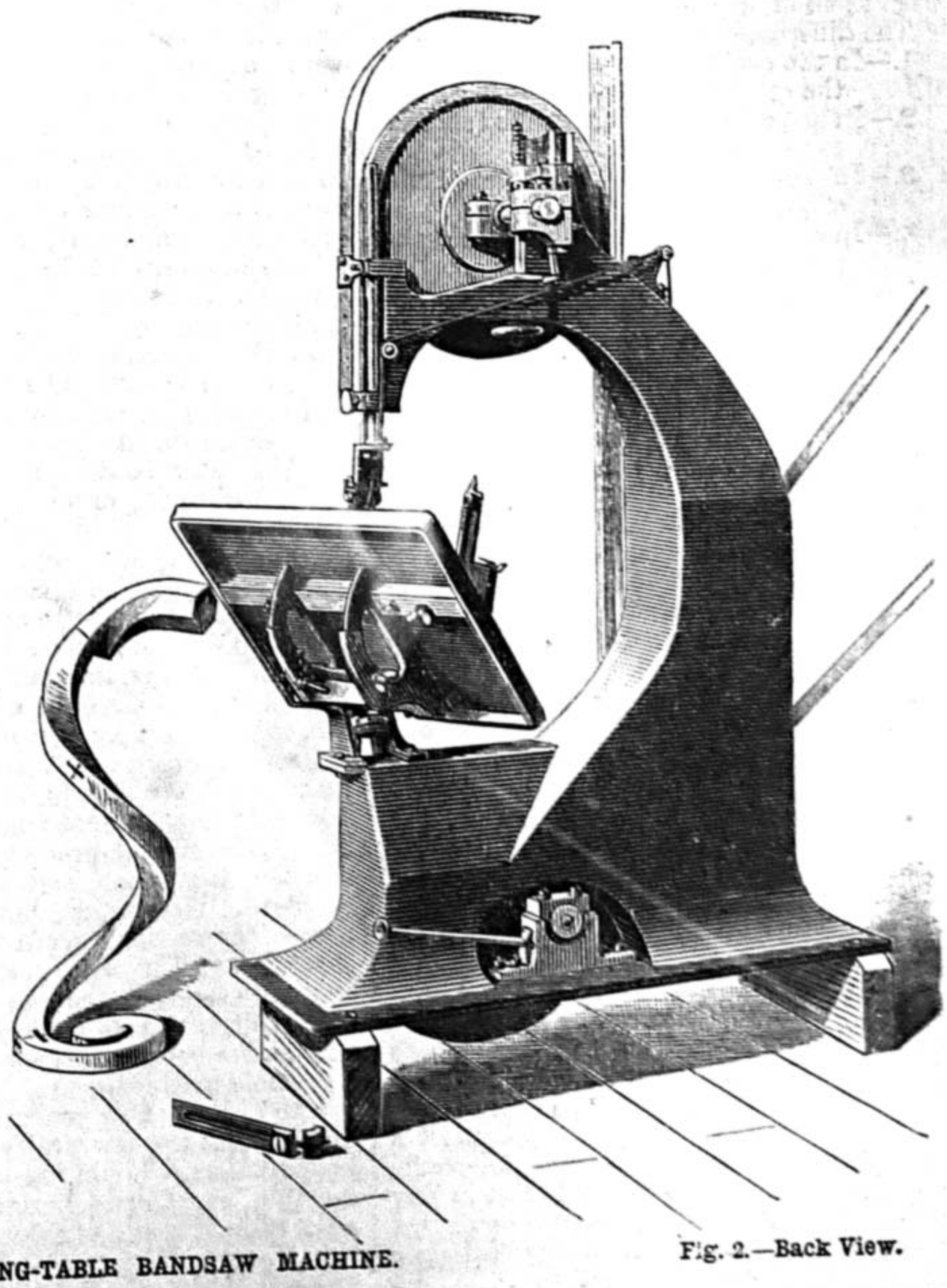

Fig. 2.—Back View.

WHIBLEY'S REVOLVING-TABLE BANDSAW MACHINE.

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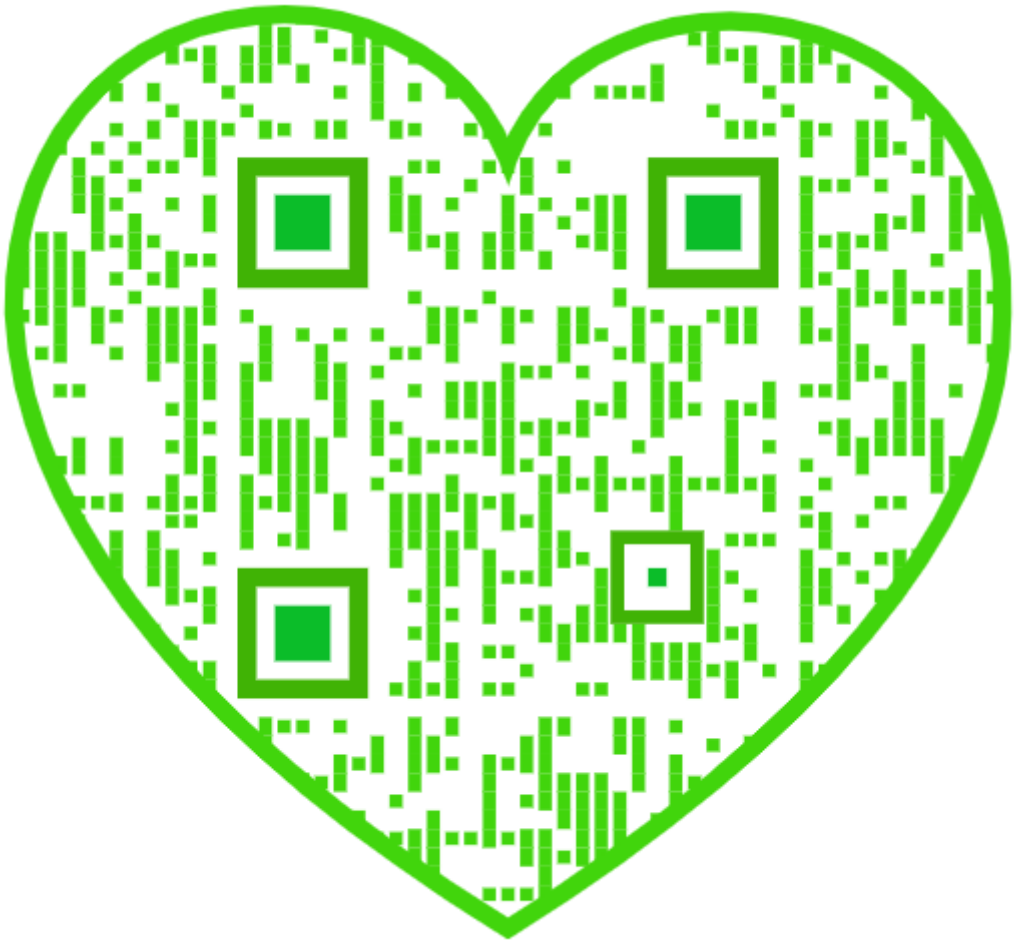

to a reciprocating frame. This was a very primitive and unpretentious looking affair, made in a few hours out of odds and ends to hand, without the outlay of a single penny, but yet it worked fairly well, and enabled me to cut out wreath pieces in the manner desired, as also other work of double curvature, etc. etc.

This machine in time gave way to a small model bandsaw machine of more substantial make, with saw pulleys 8 in. in diameter, made so that it could be driven direct from the lathe; and many and various are the forms I have produced with this mechanical toy; including among others all those mentioned in the title of this article, or illustrated in Fig. 3. A bandsaw machine with saw pulleys 30 in. in diameter, to be power driven, was next made to the order of my then employers, and has been in constant use during the past two years, giving the most perfect satisfaction, and by its performance has most conclusively established its great superiority over all others; not only for the class of work for which it is specially designed—viz., handrail wreaths and other work of double curvature—but in an even greater measure for general workshop purposes.

A half-full size wooden working model of this machine, but with such later improvements as have been suggested by experience gained in working the original, and from a continued desire to render the whole as perfect as possible, will be shown at the forthcoming "Work" Exhibition, with several specimens of work done by it.

Figs. 1 and 2 are front and back views respectively of this model, which it will be seen materially differs in many respects from those of ordinary construction.

The differences briefly stated are :—

1.—In the construction and mounting of the table.
2.—In the character of the guide fence for use upon the table.
3.—In the form and character of the standard.
4.—In the placing of the driving belt and pulleys.
5.—In the mounting of the bottom saw pulley.
6.—In the mounting of the top saw pulley.
7.—In the construction of the saw pulleys.
8.—In the character of the saw guides, both above and below the table.
9.—In the counterpoising of the top saw guides.

1. The table is constructed to cant through an angle of 60°—a far greater angle than usual with such machines—and is perfectly balanced, however placed. It can also, whether horizontal or inclined, be freely turned around the saw, and secured in any desired position by means of a clamping screw; or may instantly be adjusted and secured in any one of four primary positions 90° apart by the insertion of a locking pin in a hole provided for that purpose. The two axes about which the table turns are mutually at right angles and intersect; one coincides with the cutting edge of the saw, the other with a horizontal line upon the surface of the table.

2. Upon the upper side of this table and parallel to its horizontal axis a dovetailed groove is formed extending from side to side; in this a slide-bar or plate is fitted, of easy motion, its upper surface being even with the top of the table. By means of a clamping screw with fly nut on under side of table, this slide may be made fast in any part of the groove. It may also be caused to move freely throughout the whole length of the groove, passing in at one end and out at the other; or by the use of an adjustable stop provided, the motion of the slide in either direction may be determinate in distance, if so required. The slide is also reversible—end for end. To one end of this slide a guide fence can be attached, perpendicular to the table, but capable of angular adjustment relative to the slide. This fence consists of two parts; the fence proper, and a base plate to which it is attached at one edge, and by which it is secured to the slide in table. This fence may, when required, be caused to move freely in the direction of its length along the edge of the base plate without altering its angular adjustment relative to the slide in table; or may by means of clamping plates be made fast to the base plate. At either end of this fence and at right angles to it, another or auxiliary fence can be secured; the connection being by a simple dovetail attachment that jams and tightens upon the application of a slight pressure, and may be instantly released again by the application of a reverse pressure or a light tap at the back. This auxiliary fence has a dovetailed groove along its inner or working face, for guiding and holding an adjustable stop.

It will now be seen that the various movements of the fence, of the transverse slide in table to which the fence may be attached, and of the table around the saw, may all be effected separately or simultaneously; and that each or all may be made fast and immovable relative to the others, if so desired.

3, 4. The special character and requirements of this table; the obvious advantages that would result from having a clear working space around the machine; the unwarrantable risk of danger associated with an unnecessary exposure of fast-moving belts and pulleys; the mechanical impropriety of causing unnecessarily an external force, as that of the driving power, to act ex-centrally upon the machine; and various other minor considerations, chiefly of a mechanical nature, led to the designing of the standard or body of the machine, different in many important particulars from those in general use.

In this machine the standard is formed hollow and open at the bottom and back, and encloses the driving pulleys and belt; the arrangement being such that the machine may be driven direct from overhead, horizontal, or underground shafting; the angular range through which the belt may be placed exceeding 200 degrees, an angular range far in excess of that which is practically possible with any other machine of the kind. By thus enclosing the driving belt and pulleys, immunity is also secured against what is not only a serious obstruction to free working around the table, but likewise an ever-present element of danger that invariably exists in all other bandsaw machines as now made, owing to the hitherto universal practice of placing the driving pulleys and belt external to the standard. Greater compactness and neatness of appearance are also obtained, and steadier running with total absence of perceptible vibration, consequent upon the pull of the driving belt coinciding with a plane that passes through the centre of gravity of the whole machine.

5, 6, 7. It is now generally agreed among experts that the saw pulleys, especially the upper pulley, should be of the lightest possible construction, that the resistance alike of inertia and of friction may each be a minimum; otherwise the strain upon the saw when the machine is started, especially if suddenly started, may cause it to break. For this reason cast-iron pulleys are unsuitable; they are too heavy, and if run at high speed are apt to fly in pieces. Wrought-iron pulleys are both lighter and stronger, and are now generally used by good makers; though for the upper pulley some prefer wire wheels of similar construction to bicycle wheels. What in my opinion is preferable to open metal wheels for saw pulleys, and what I have decided to use for this machine, are solid wooden wheels formed of a number of thin boards glued together, the grain of adjacent pieces crossing, and the whole subjected to sufficient pressure to expel all surplus glue and bring wood to wood. A circular row of copper rivets passing from side to side near the outer edge prevents any separation there of the component layers, and the centre is firmly bolted between a loose annular plate and the radial flange of a cast-iron hub. These pulleys are cheap, light, and durable, and may safely be driven at the highest possible speed, while the retarding influence of the air is far less for them at high speeds than for open wheels, especially those with many spokes, as in the bicycle wheel variety. This means less pull upon the saw, and consequently less danger of breakage. Nor are open pulleys so safe as solid ones, as foreign substances are apt to get between the spokes with results that may prove disastrous. A thick indiarubber tyre completes these pulleys: this forms an elastic bed for the saw to run on, and still further reduces the strain upon it at starting.

In the early forms of bandsaw machines the saw pulleys were formed with a radial flange to the outer edge upon the back side to prevent the saw running off, the edge being slightly coned upwards towards the flange to ensure the running of the saw against it. This is for some reasons an unsatisfactory arrangement, and is never used now for first-class machines. A better and more approved way is to have the spindle of the upper saw pulley adjustable from the horizontal in such a manner that the plane of pulley can be thrown out of line with that of the lower pulley. By this means the saw can be caused to run upon any desired part of its periphery, and a flange is not needed. Each saw requires its own special adjustment, as different saws run differently; a slight variation in their width or set causing a considerable variation in the positions they will run to on the pulleys. It will be readily seen that a wide saw lightly set is practically a flat band, whereas a narrow saw heavily set is essentially a triangular or wedge-shape band of pronounced form, and that an adjustment of pulleys upon which either of these would properly run would be such as the other would immediately run off of.

In some machines the upper pulley runs upon a fixed spindle, connected by a knuckle joint to the elevator, by which it is raised or lowered to suit saws of different lengths, its plane being thrown in or out of line with that of the lower pulley by means of an adjusting set screw that is always more or less inconveniently placed, and can only be operated when the machine is at rest. In other machines the pulley is made fast to a running spindle that works in bearings, usually adjustable for wear, that are connected to the elevator. In these the point or centre about which the pulley is adjusted to regulate the running of the saw is usually so far distant from the pulley that any alteration for the purpose of

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adjustment alters the tension of the saw, in extreme cases to such a degree that the saw becomes unduly strained and may break. In addition to the advantage of adjustable bearings to take up wear, this arrangement has a very considerable advantage over the previous form, in that the running of the saw upon the pulley may be adjusted to the greatest nicety whilst the machine is working.

In the machine here shown the upper saw pulley is fixed to a running spindle that works in bearings adjustable for wear, but the centre about which the pulley is canted to suit the different saws is placed close against the pulley, thus avoiding any alteration of tension in the saw when adjusting same for running. The position and form of the adjusting screw have been specially designed to place it within easy reach of the operator when standing in a position where he can observe every movement of the saw upon the pulley. The lower end of the screw-stem is made to terminate in a small hand-wheel head, to enable it to be turned without the aid of spanners or the like. By this means the saw can be adjusted with far greater facility than is possible in other machines.

Another and a very important feature of this machine is that the lower saw pulley, like the upper one, is adjustable for cant relative to the other. This, though very desirable, has never previously been done. The means by which it is effected are both simple and novel, and this pulley can be adjusted with equal facility to the other.

8. The saw guides of this machine, both above and below the table, differ in many respects from those in general use. The most general and certainly the simplest form of saw guide consists of a block of hard wood severed across the grain, the saw working between and being laterally supported by the cut surfaces. Sometimes the block is but partially cut through, so that the back of saw runs against the wood; sometimes completely through, and the back of saw caused to run against a hard metal surface, usually of steel tempered dead hard. The saw cuts in these blocks quickly enlarge with wear, due to the friction and vibration of the saw, and are then comparatively useless to prevent any bending or twisting of the blade. This defect some makers seek to remedy by substituting metal guides in lieu of the wooden blocks at the sides of saw. Whilst the saw is clean and of even thickness this answers very well, but if the saw has been improperly brazed and the metal left extra thick or kinked at the join, or if it has accreted resin or other like substance from the wood during working, it is very liable to jam in these guides and break. Nor is the use of exceedingly hard steel bearings for the back edge of saw to run against free from serious objections. However hard these bearings may be the saw will surely cut into them, and, as constructed, are usually expensive to repair or renew. But a far more serious objection is that being so hard they compress and stretch the softer metal of the saw, producing at its rear edge a stress of increasing intensity that ultimately renders an otherwise good saw practically worthless, because once a saw breaks as the result of tensile weakness consequent on the action of this stress, it hardly pays to be repaired again, as break follows break in rapid succession.

The records of the Patent Office give evidence of much thought and ingenuity having been exercised to produce band-saw guides that a running saw would not destroy; the effect of the guide upon the saw being invariably overlooked, with the result that in nearly every instance the evils I have pointed out exist in these in an augmented form.

The saw guides of this machine are free from the objections urged to the foregoing. In this the saw is kept in line and prevented from bending or twisting by means of two friction rollers, one on either side. The bearings of these rollers are each connected to a thin steel plate that forms a stiff spring tending to press them closely together, and by means of a set screw to each can be adjustably separated for the saw to pass freely between; thus jamming is impossible consequent upon any increase in the thickness of saw by accretion upon its surface, or other causes, as any such increase of thickness would simply bring the saw in closer contact with the rollers, or cause them to yield outward subject to the pressure. The rear edge of the saw, both immediately above the work and below the table, is caused to bear centrally lengthways against a piece of thick wire several inches in length of some comparatively soft and self-lubricating metal, such as phosphor bronze, or any other more suitable metal that can be had. The object of having a long bearing surface for the back of saw to run against is to obtain an extended distribution of pressure, and consequently a small unit pressure of saw per unit length of bearing. By this means the back edge of the saw is protected from injury, and the wire bearing when cut into—which under these conditions takes place very slowly—can be partly turned round to present a fresh surface for the saw to bear against, or replaced by another piece in a very few minutes.

9. It has of late years become the practice of some makers to balance the weight of the top saw guides and attachments by means of a counterpoise, suspended by a cord or chain over a pulley near the upper end of the slide bar to which the guide block is attached. Thus balanced, the guide can be raised or lowered with ease and safety to suit the thickness of stuff, even during the process of cutting, as one hand is sufficient for that purpose. This is a great improvement over the unbalanced guide, and is one that every machine ought to possess. A disadvantage to the usual form of this arrangement is, that as the guide is raised the counterbalance descends, and is apt to be very much in the way. It certainly would be so in such a machine as I have described. There is also the risk of the supporting cord or chain breaking, or in some other way becoming disconnected, in which case the effect of the weight falling upon the table or the work would almost certainly prove disastrous. These objections I have provided against by suspending the balance weight within the hollow back of the standard, the cord or chain being guided over pulleys, as shown in the back view of the machine (Fig. 2).

This detailed and comparative description will be, I think, sufficient to clearly show the distinctive differences between this machine and others.

From what has been said, it will be understood that the principal object aimed at in working out the details of this table and its attachments was the production of a machine wherewith the twisted snake-like forms of handrail wreaths for stairways, and the rails of double curvature in circle-upon-circle work, could be cut by saw to the "squared" or straight line section to which this work is always brought before being moulded, it being evident that a considerable economy of production must thereby result, as the "squaring" of these rails by hand involves a large amount of heavy but highly skilled labour at the bench, and consequent expense. For this purpose it has proved an unqualified success; whilst for dovetailing, and the forming of angular and oblique cuts of every description, it has been found uncommonly useful. The ready facility, too, with which this table and its fences can be adjusted and operated in adaptation to innumerable conditions of constant occurrence in workshop practice, renders it even more valuable for general purposes than for the work for which it is specially designed.

SURFACE PLATES: A HINT.

BY ARTHUR BOWES.

An accurate surface plate is one of the necessary tools for the production of metal work where the various parts of a machine are intended to work in contact with each other with a minimum of friction and perfect regularity of motion. To produce this essential tool, the usual method is to adopt the procedure introduced by Sir Joseph Whitworth, and explained by him in a paper before the British Association just fifty years ago. Briefly described, the method is this—dealing first of all, for the sake of simplicity, with the production of a straightedge. Three straightedges are prepared at the same time, and after preparing each one singly, and bringing it to a moderate state of accuracy, two of them, which we will call A and B (see Fig. 1), are compared with each other by placing them edge to edge. Any irregularities which may be found are removed, and the process repeated until A and B fit each other perfectly. The third straightedge, C, is now taken in hand and compared with both A and B, and when it is found that it will fit perfectly either A or B, then there is no doubt whatever that the three are all accurately straight—not perhaps mathematically straight, but approximating to the truth in proportion to the labour that has been spent upon them. Why this is so will be seen from Fig. 1, where it is obvious that if A is rounded instead of being straight, B may be hollow sufficiently to make them fit each other perfectly, but it is impossible that C shall fit both the rounded and the hollow straightedge.

In the case of surface plates the same system is adopted, three castings being worked upon in conjunction with each other, and compared in couples. As described in a well-known and valuable work, after working up one surface plate to the utmost perfection "its face is now thinly coated with ochre and oil, B and C being successively made counterparts of it by repeatedly placing them face downwards on A, and then lowering with the scraper all the reddened parts on which they bear. This must be continued till the contact between A and B, and A and C, is as perfect as possible." At first sight it would seem that these instructions, if carefully carried out, were sufficient to ensure accuracy in the plane surfaces, and it will no doubt be a surprise to many to learn that three surface plates may be made to compare with each other in this way, any one with each of the others, and fitting each other with such accuracy as to enable us to grasp the handles of the upper plate and lift up the lower one

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by atmospheric adhesion, and yet they may be very far from being plane surfaces. Most readers of this Journal will know what is meant by a surface being "in winding"; for those who do not, Fig. 2 will explain what it is more clearly than a long description in words. It will be seen that the two

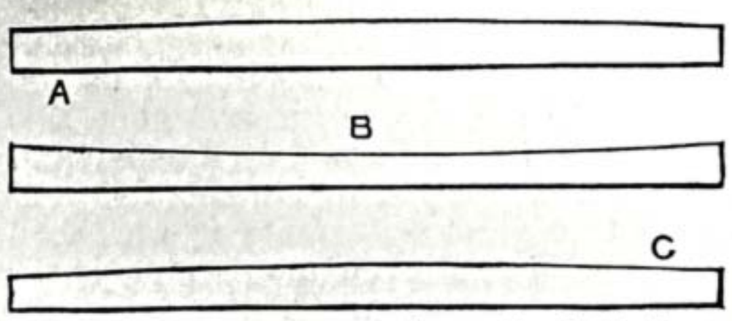

Fig. 1.—Method of preparing a Straightedge.

corners X and Y of the surface stand higher than the other corners—in fact, that the surface "winds" or twists. Now, the three surface plates under consideration may all be in winding, and yet fulfil all the above conditions.

Perhaps the easiest way to see the reason of this is to take three pieces of wood or cardboard, such as are lettered A, B, and C, in Fig. 3, insert drawing pins, or stick on wafers, or if you prefer it merely make pencil marks in the diagonal corners, in the position indicated by the mark X, and imagine that each of these marks represents a raised portion of the surface plate—that is to say, that the plate is "in winding." Now place your pieces of wood or cardboard

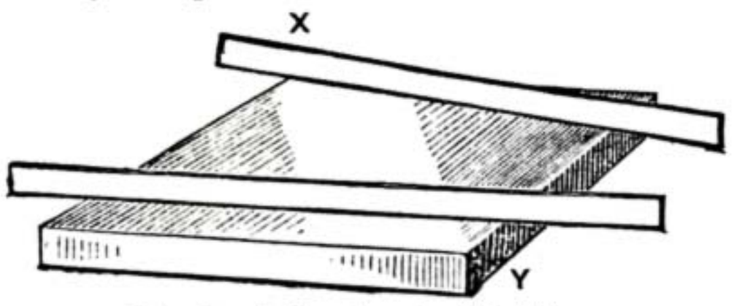

Fig. 2.—A Surface in Winding.

face to face in every possible combination, and you will find that shuffle and turn them end for end as you will, the raised corners will always come over the depressed corners, and if each plate is in winding to the same extent the error cannot be detected by laying one surface on the other.

What is the remedy? Well, having once seen where the possibility of error comes in it is easy to avoid it. The surface plates should not merely be laid upon each other in testing one with the other, they should be turned round through quite a quarter of a circle, when the high parts of one will be brought in contact with the high parts of the other with which it is being compared. In this manner only is it possible to ensure

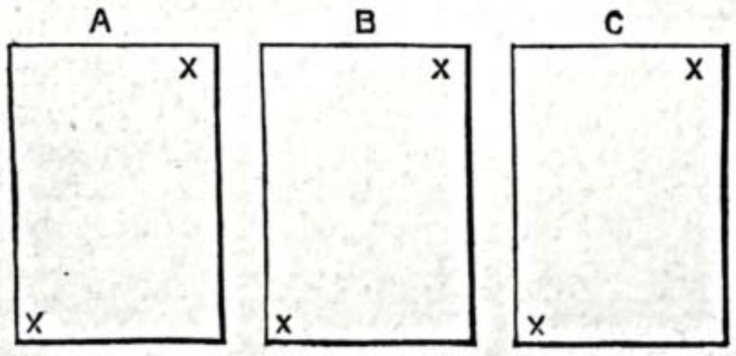

Fig. 3.—Diagram of Surfaces in Winding.

that the surfaces shall be perfect planes. A further extension of the idea might suggest that the best form of surface plate to ensure accuracy is *circular* and not rectangular—that is to say, in the form of a round disc or plate, and not in the form of a square or oblong piece of metal—whose four corners are right angles, as represented in the winding surface plate with straightedges applied to it, illustrated above in Fig. 2.

MODEL ELECTRIC LIGHTS.

BY GEORGE EDWINSON BONNEY.

Small Dynamos for Electric Lighting.

Winding Laminated Armatures.—Whilst winding the wire on the armature or the field magnets of a dynamo, great care must be exercised to get each coil of wire close to its neighbour, and each layer of wire regular and close to the layer beneath, for on this will depend the full efficiency of the machine. Slack and irregular winding will cause loss of power, and this is specially observable in the winding of the armature, where cross winding will not only prevent a sufficient number of coils being got in a given space, but also cause cross currents in the wires. But whilst giving all attention to the tightness and snugness of the winding, it is possible to be too zealous in this direction, and fall into the more serious error of pulling the wire so tight over the iron ends of the armature as to cause the iron to cut into the covering of the wire. One such abrasion of the covering, however small, will render the machine useless, as the current will travel by this small contact through the iron of the machine instead of through its wire coils. To detect such accidents as these (and they are of frequent occurrence) it is necessary to have a small galvanometer, or current detector, and with it test the insulation of the covering as we proceed. Almost any price may be paid for a galvanometer, from 2s. 6d. up to £10, according to the value of material and workmanship put in the instrument; but a plain and simply constructed one, good enough for this purpose, can be got for 10s., or perhaps less, from any vendor of dynamo castings. To test the wire for complete insulation whilst winding, connect the free end of it to one stud of the galvanometer; connect the other stud to one terminal of a good battery (one cell of a Bunsen or a bichromate will do very well), and attach a length of wire for testing to the other terminal of the battery. With the end of this wire touch the bare iron of any part of the armature (or of the field magnets whilst winding them). If the needle of the instrument moves, and is deflected to one side or other of the zero mark, we may take it for granted that the wire covering is abraded, and must then unwind each coil until the faulty place is discovered. Such faults are best repaired with a thread of unspun silk or of soft darning-cotton, soaked in melted paraffin and wound around the abraded spot. If the needle does not move at all when the iron is touched with the battery wire, we may be certain that the coil is insulated from the iron of the field magnet core, or from the iron of the armature. Greater care should be exercised in winding a laminated armature than in winding one having a solid core, since the edges of the plates are liable to cut through the protecting coat of silk and the covering of the wire, if this is pulled too tight over the edges. Some little difficulty also will be experienced in getting the coils of wire to lie close to the spindle whilst winding them on one side. This little difficulty may be met by tying each coil back with a short piece of tape, until the curvature of the spindle has been passed. In winding a laminated H girder armature for a Manchester field, the coils may be prevented from slipping at the ends by turning forward two of the laminated plates at each end, so as to form two flanges, against which the coils can rest as against the sides of the end slot in a solid armature. As there are no spindle holders to pass the ends of the coil through, we have to fasten them down to the sections of the commutator direct, to which they should be secured by soldering them to the inside edges. It will also be advisable to tie the ends down to the spindle with a few turns of tape, to prevent the outer coil from being shaken loose in working.

Winding the Field Magnet Cores.—Before winding the field magnet cores, it will be necessary to prepare them for the wire by wrapping around them a layer of silk ribbon well soaked in melted paraffin, and applied to the iron hot. This must then be made quite smooth. The wire must also be prepared for winding by first dividing the allotted quantity into two equal parts, making these into hanks or coils large enough to go loosely over a two-gallon stoneware jar, and well soaking them in melted paraffin. The wire may be divided by measurement, if it is found inconvenient to divide it by weight, if we remember that No. 22 B.W.G. d.c.c. copper wire measures 120 yards in the lb. The wire may be wound on by hand if the amateur is unprovided with a winder or a lathe, but it can be more regularly, smoothly, and tightly wound in a lathe, or by means of a winding apparatus. This can be easily and cheaply made up for the purpose out of a few scraps of wood, a few bolts, and a winch handle. Centre the field magnet casting in the lathe, and when it runs true, proceed to wind on the wire. If the hank of wire is placed over a glazed stoneware bottle filled with water, the coils will slip off easily as we wind the wire on the casting. Commence at the channel or bottom end of the core; wind some seven or eight inches of the wire on a pencil to form a close spiral, to be stretched out after winding to form connections with. Lay this close to the bottom end, take one turn around the casting, and secure the spiral to this with a piece of strong twine. Wind on the coils evenly side by side, and when within two inches of the end, lay in two four-inch lengths of tape under the last few coils on the outside of the core, leaving the ends hanging. Before winding back with the next layer, bring the ends down over the first layer, and thus secure the last few coils of the first layer from slipping away under the pressure of the next. If the ends of each layer are thus bound, there will be no danger of the overlying layer sinking in between the coils of that just beneath it. When the wire has been all wound on, tie the free end to one of the coils, or to the core, with a piece of stout twine. Serve the other field magnet core in a similar manner, testing each layer for insulation as the work proceeds; then coat the wires with a layer of sealing-wax varnish, and set them aside to dry. As the cores of some other field magnets are unprovided with flanges, this method of taping just described will be found very convenient in preventing slipping of the end coils, but flanges are preferable where these can be introduced, as they not only effectually prevent slipping of the end coils, but also protect the coils from injury when the pole pieces have to be screwed on after the cores are wound.

Fitting and Erecting the Machine.—The various parts having been prepared, we must now set about putting them together, fitting each in its proper place, and making the whole up into a dynamo-electric machine. The field magnets must, when at work, form the two limbs of a horse-shoe magnet, the extremity of one limb forming the north pole of the magnet, whilst its opposite forms

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the south pole. It is well known that a straight bar magnet has two opposite poles—one at each end. One of these will attract the south pole of a compass needle, and is therefore called the north pole of the magnet, its opposite being the south pole. If now we bend the bar in the shape of a horse-shoe, the two poles are brought near each other, but they still preserve their characteristic opposite polarities. If we wind an insulated wire around a piece of steel, or of iron, from left to right, and send a current of electricity in the same direction through the wire, we shall find that the left-hand end of the iron or steel bar has assumed a north magnetic polarity, and at the same time its opposite end has a south magnetic polarity. Bend the bar into the shape of a horse-shoe with the wire on it, and it will then resemble the two field magnets of this machine, with a hollow curve between the legs for the armature to revolve in. Now, we want to make the two field magnets like a horse-shoe magnet, with a north pole on one side of the armature and a south pole on the other side. As both of the cores have been wound from the bottom or channel end, it follows that if we send a current through each separately in the same direction in which they are wound, the two bottom cheeks would be both north poles, and if we connected the finish end of one coil of wire with the commencing end of the other, we should realise the same result; but if we connect the two finish ends of the coils together, as shown at Fig. 36, and send a current from the left-hand end to the right, it will enter at N, traverse the coils in the direction shown by the arrow, leave at S, cross over to the right-hand core, and traverse its coils in the opposite direction, thus causing a south pole at the bottom and a north pole at the top. How shall we determine the direction of the current? This is determined by sending a current from one or two quart Bunsen or bichromate cells through the coils, taking care to connect the carbon of the battery with N on the left, and the zinc of the battery with S on the right. As the current from a battery always starts from the zinc and moves towards the carbon, we can by this means always ensure sending a current in the right direction. When thus magnetised, the field

Fig. 35

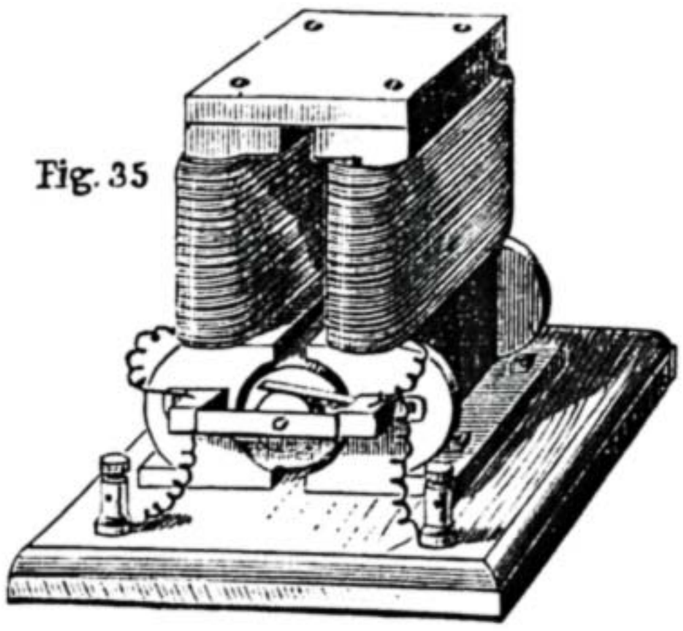


Fig. 36.

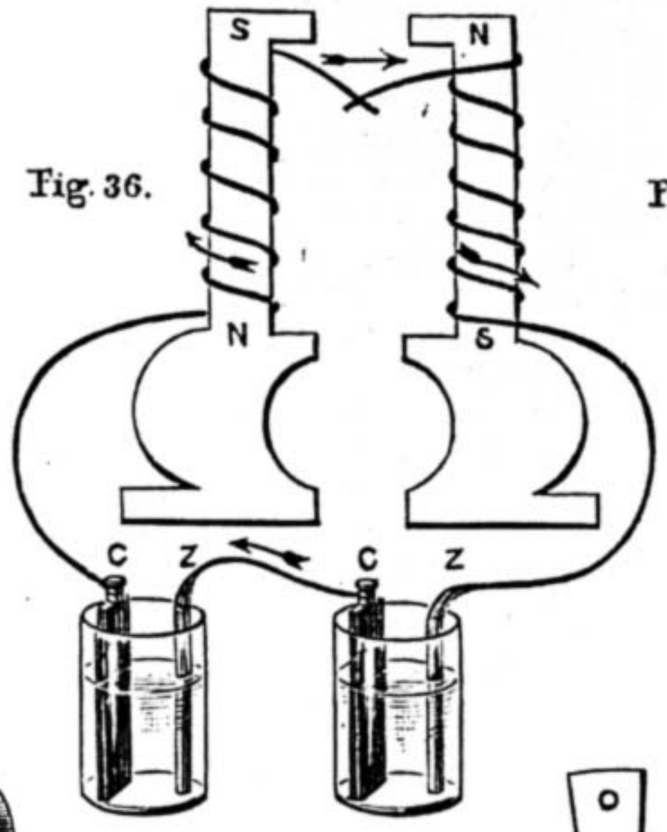


Fig. 37.

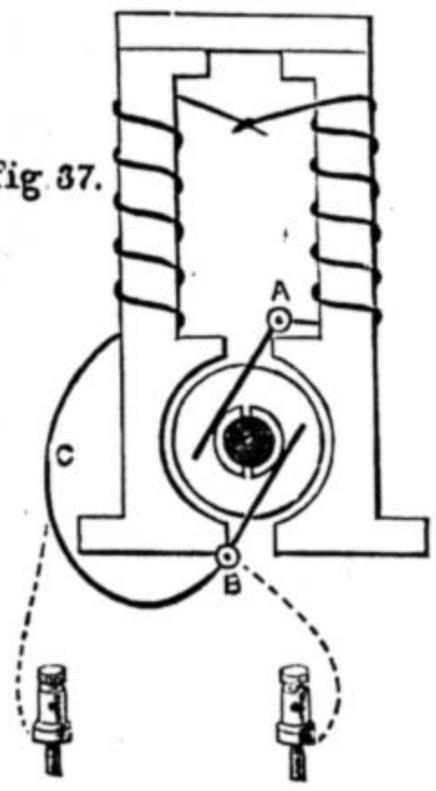
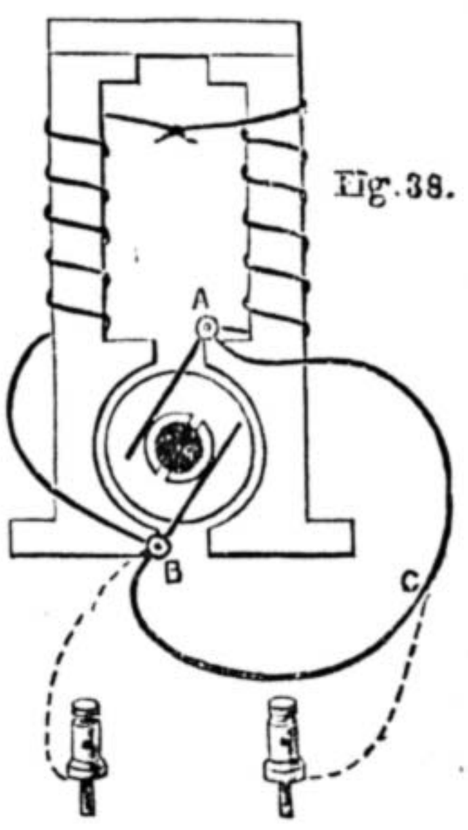


Fig. 38.



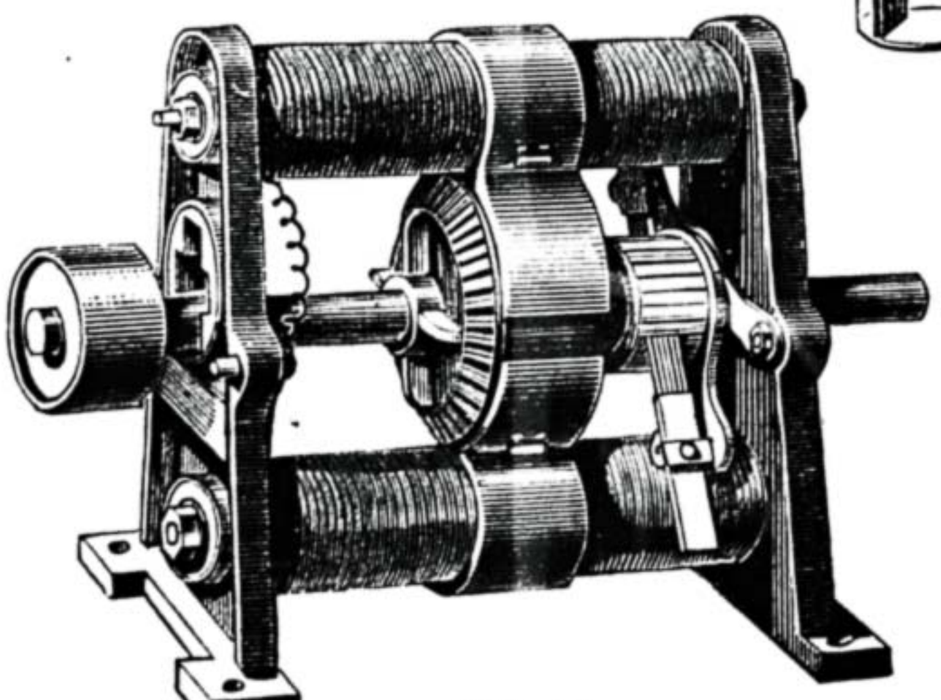


Fig. 39.

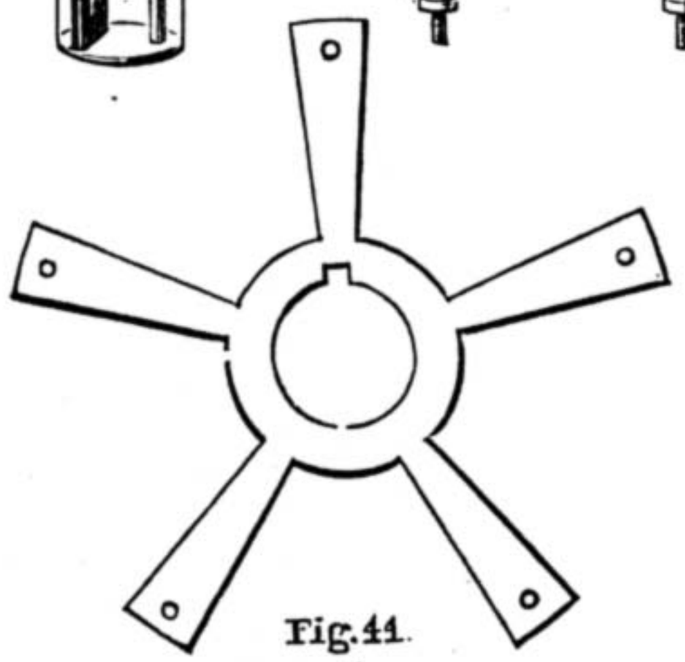


Fig. 41.

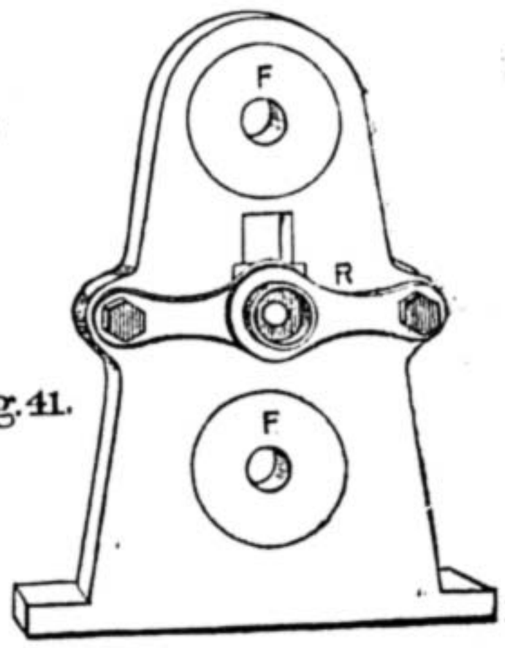


Fig. 41.

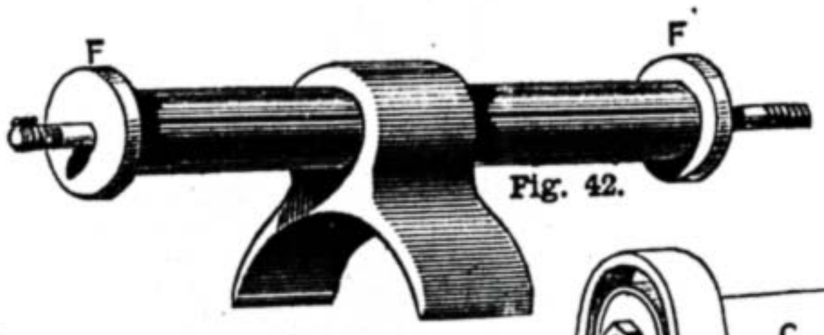


Fig. 42.

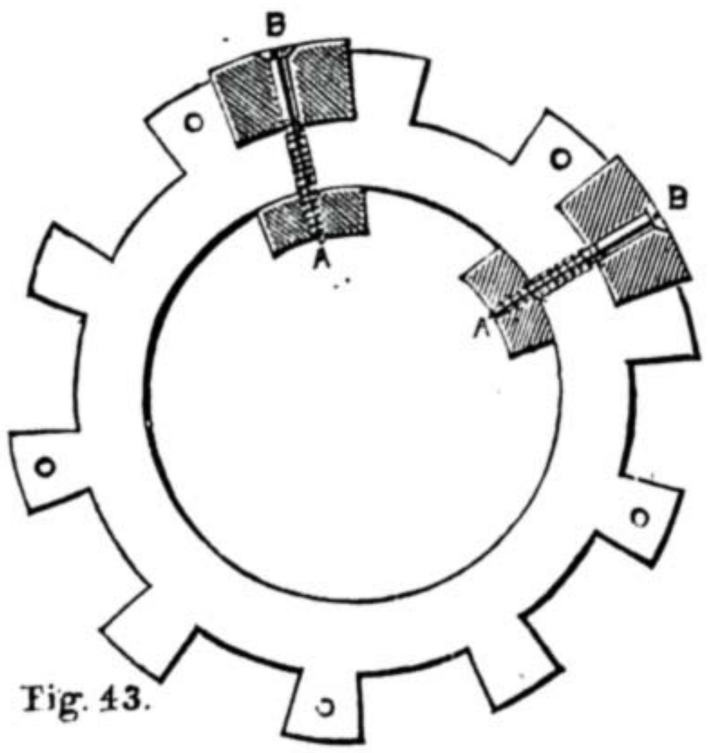


Fig. 43.

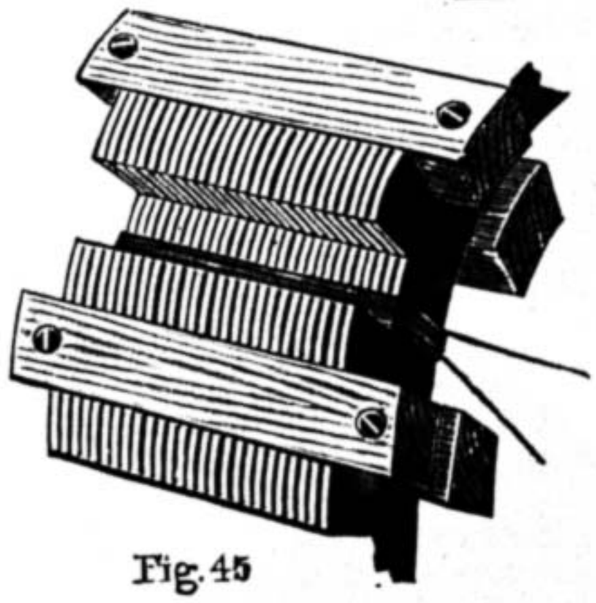


Fig. 45

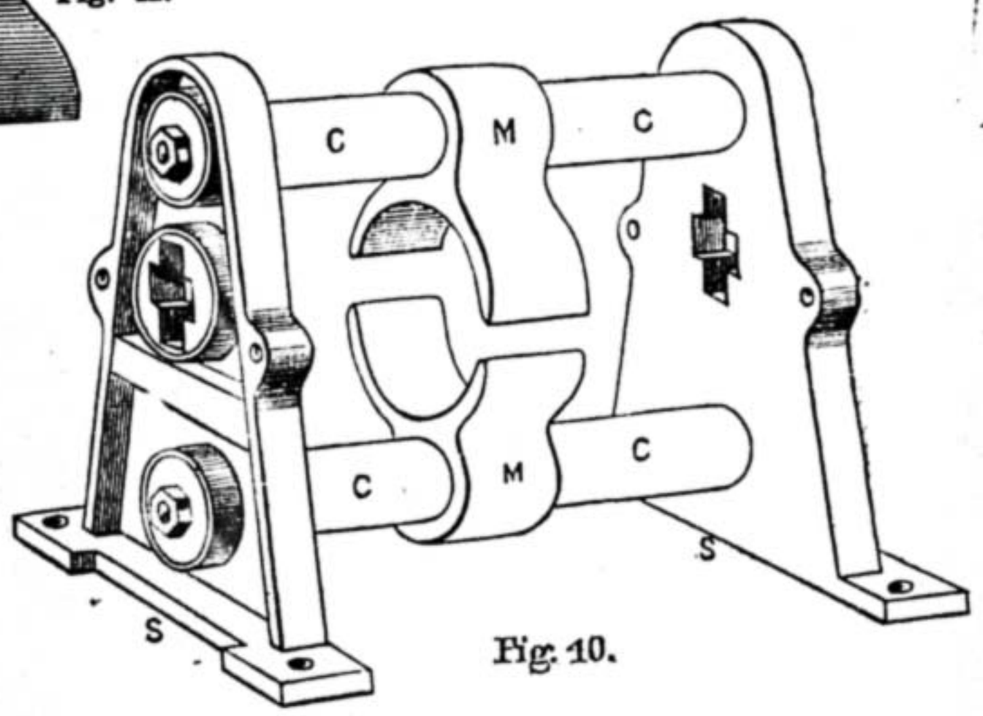


Fig. 10.

Fig. 35.—Model Siemens Dynamo complete. Fig. 36.—Diagram of Dynamo Field Magnets, showing how they are magnetised. Fig. 37.—Diagram of "Series" Connections for Dynamo. Fig. 38.—Diagram of "Shunt" Connections for Dynamo. Fig. 39.—Model Gramme Dynamo complete. Fig. 40.—Iron Carcase of Gramme Dynamo—S, S, Standards; M, M, Cheeks of Magnets; C, C, C, C, Cores of Magnets. Fig. 41.—Inside of Standard fitted with Bridge for Brush Holders. Fig. 42.—Magnet Cores with Flanges. Fig. 43.—Laminated Iron Punching for Armature. Fig. 44.—End Support for Laminated Punchings. Fig. 45.—End of Armature ready for winding.

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magnets may be connected together and the machine set up.

The field magnets are fastened securely together by the yoke at the top, but to ensure proper rigidity and stability to the machine, they must also be firmly secured to a thick well-seasoned slab of oak, teak, walnut, or mahogany by short coach screws passing through the lower outstanding flanges. This may be trimmed at the edges, and nicely planed and polished, to ensure a finished appearance.

Making the Connections.—Owing to the simplicity of design, the Siemens machine lends itself readily as a subject wherewith to illustrate clearly how the wires of a dynamo should be connected. Figs. 37 and 38 show two distinct methods of connecting the wires. The method shown at Fig. 37 is known as connecting the machine in series—that is to say, the field magnets, the armature, and the work to be done in the outer circuit, may be regarded as three cells of a battery, and the whole connected up one after the other in one circuit, so that all the current must pass through each of them. Like a battery also, no current can pass through the field magnet coils until the outer circuit is completed. If one end of the field magnet wires is connected to the brush A, and the other end to the brush B, as shown in the diagram Fig. 37, the machine will be short-circuited. But if we break one of the wires at C, and take it to a binding screw, then take the piece hanging to B, and connect that to another binding screw, the two screws will form the two poles of the machine, to which the wires from the outer or working circuit must be attached. This method of connecting the wires is only suitable when the machine has to do steady definite work in which the resistance does not vary.

Fig. 38 shows a method of connecting the machine in shunt, as it is termed—that is to say, a part of the current generated in the machine is always passing through the coils of the field magnets, and thus they are always kept magnetised. This may be done in one of two ways. The wires are first connected as in the first case—that is, in series—and then the brushes A, B, are bridged with a fine wire offering a higher resistance than any work likely to be introduced in the outer circuit. The two brushes A and B are then connected by thick wires to the two terminal binding screws of the machine. This method has the disadvantage of opposing a useless resistance to the current in the circuit—one that absorbs heat and gives back no equivalent—and also, by means of this resistance, prevents the full power of the machine from being developed. The most approved method, therefore, is to wind the field magnets with a wire having a definite resistance, and this so balanced with the resistance of the wire on the armature as to ensure a definite output of electricity from the machine. The two ends of the field magnet coils are then connected to the two brushes, and these are both connected to the binding screws which form the terminal poles of the machine. The circuit is now divided, part of the current going through the work in the outer circuit, and part going through the field magnet coils. When the resistance in the outer circuit falls, less current goes around the field magnet coils; the E.M.F. of the current also falls, and thus the machine regulates its output of current automatically, since the strength of the current is proportioned to the strength of the fields. On the other hand, should the resistance rise in the outer circuit, the effect will be to throw more current through the field magnet coils through the shunt, and thus strengthen the fields to overcome the increased resistance. This is the method of connecting adopted in dynamos intended for incandescent electric lamps, and is applicable to all machines described in these series of papers. Those of my readers who may wish for more detailed information respecting the small dynamo just described may find what they require in a little book on "The Dynamo: How Made and Used"—a book for amateurs, by S. R. Bottone, published by W. Swan Sonnenschein & Co., price 2s. 6d. This little book of seventy-three pages deals in the first twenty-eight pages with the theoretical principles involved in the making of a dynamo; in the next ten pages it shows how to make the patterns for the castings of a small Siemens dynamo; and in the remaining pages gives practical illustrated details of its construction. It will be found to be a useful book for amateurs.

The Gramme Dynamo.—In 1871 a French electrician, named M. Gramme, invented a dynamo in which he used a ring of soft iron wires wound in sections with insulated copper wire as the armature. Although he was not the first to use a ring armature made of iron, he was able to patent his modification, and this gave birth to the form of armature which has since been modified and altered in many different ways, but is still known as the Gramme ring. The patent expired in 1884, and since that time the machine has been copied and the copies turned out in great numbers by makers who waited until this good time to avail themselves of the benefit of Gramme's valuable invention. Among the many modifications of Gramme's iron ring may be mentioned armatures made up of insulated hoop iron, flat rings of iron plate bolted together, and semicircles of sheet iron bound together with wire. All these, including the Gramme ring itself, must, however, be regarded as imitations of a discovery made in 1860 by Dr. Antonio Pacinotti, Professor of Technical Physics at the University of Pisa, in Italy. This renowned professor discovered that he could make a most efficient dynamo by employing as an armature, a cogged iron wheel with sixteen cogs, and winding between the cogs sixteen spirals of insulated copper wire. Here, then, was the first ring armature, imitated since in many ways by numerous modifications.

Among the several makers of dynamo machines who availed themselves of the expiry of the Gramme patents in 1884, was Mr. Alfred Crofts, of Dover, who commenced practice for himself as an amateur electrician, and developed into a professional one under the stress of circumstances induced by the wants of other amateurs. Mr. Crofts devotes his attention to the development and manufacture of the Gramme machine, because, as he says in his little book on "How to Make a Dynamo":—"The Gramme presents fewer constructional difficulties than some of its competitors, and produces a direct current at a moderate speed." Some idea of the general appearance of a Gramme dynamo will be gathered from the illustration (Fig. 39), which represents a small model Gramme machine complete.

The Carcase of the Machine.—The carcase of a Gramme machine differs in form and structure from that of other machines. A general idea of its form is given in Fig. 40, where S, S, represents the iron standards or supports; C, C, C, C, the iron cores of the field-magnets; and M, M, the cheeks of the field magnets, forming a tunnel in which the armature revolves. The whole may be made of wrought-iron forgings, but the labour of making and fitting these would be a heavy task, and would never repay the amateur for his outlay in face of the fact that soft iron castings can now be so cheaply obtained from the makers. The castings will be received rough as they come from the foundry, and must be put into shape and fitted for use by the dynamo maker himself. The first thing to be considered and taken in hand will be the standards, one of which is shown at Fig. 41, fitted with a bridge for the brush holders. It will be seen, on referring to Fig. 40, that each standard has two projecting legs, one on each side. The uses of these are: in one standard to hold the bolts which support the bridge of the brush holders, and in the other standard to hold the screws which form the terminal poles of the machine. The bridge should be one of the iron castings sent with the carcase. This must be mounted on the face plate of a lathe, the inside of the hub of the bridge turned to allow the spindle of the armature to pass freely through it, and a ring formed on the outside of the hub to hold the ring of the brush holder. The holes F, F, above and below the bridge are for the bolts of the field magnet cores to pass through, and as it is most important that the flanged ends of these cores should be in clean and perfect contact with the iron of the standards, it will be advisable to mount the standards in a lathe, and surface the rough iron within the radius of the rings shown, or enough to match the bright ends of the turned core flanges. Holes must also be bored in the feet of the standards, to receive bolts for bolting the machine to a bench or to the floor. The other standard must now be treated in a similar manner, but in this the holes in the lugs will be used, when plugged with ebonite, to hold the terminal binding screws of the machine. The cross-shaped slits in each standard are intended to hold the brass bearings, which are fitted into the slits below the cross, and held in position by small wedges.

The Field Magnet Cores.—These are best when cast with the cheeks, or pole pieces, and the flanges in one piece, and also with the shank of a wrought-iron projecting pin or bolt embedded in the casting at each end (Fig. 42). Perfect contact is then ensured between all the parts, and this is important in order to maintain magnetic continuity between the pole pieces and their yokes—the standards. The outsides of the flanges where they are to meet the bright circles on the standards should be turned down true and bright, to ensure a clean and true fit. When both cores with their pole pieces have been fitted to the standards, the ends of the projecting pins screwed and fitted with nuts, and the cheeks are seen to hang in line with each other, it will be well to bolt all up tight, mark the positions of each piece by small nicks with a file, on flanges and standard, and drill two $\frac{3}{8}$-in. holes (one on each side of the core) through each flange and into the standards to the depth of $\frac{1}{4}$ in. If iron pins are now fitted in these holes and fixed in the flanges, they will guide the workman in fitting the parts after the cores are wound with wire, and also ensure the cores being placed in their right position.

The Armature.—The armatures of these small model Gramme machines are not now made of iron wire, as in the machines made by their inventor. They are now built up of laminated punchings or rings of sheet-iron, cut as shown at Fig. 43, with a number of cogs on the periphery of each ring. It will thus be seen that the armature of the

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Gramme machine is nothing more or less than a Pacinotti cogged ring armature. The number of cogs and intermediary spaces are arranged to suit the designer of each machine, and may be any even number, such as ten, twelve, fourteen, sixteen, and so on. In the small machine shown, the number is ten. As these small laminations run from fourteen to twenty-five to the inch in thickness, a large number of them are required to build up an armature. The method of building up is as follows: small holes are drilled in each alternate cog of each lamination, as shown at Fig. 43. These holes may be ¼ in. or ⅜ in. in diameter, but they must exactly coincide with each other through the whole number of plates, as they have to form continuous holes through the plates to admit brass rods on which the laminated plates are to be threaded. The rods must be of brass, to avoid magnetic complications in the armature when at work. Both ends of each brass rod must be cut with a screwed thread, and fitted with small hexagonal nuts. The plates must next be coated with good tough varnish, such as Japan or Brunswick black, and set aside until the varnish is dry and firm. They are then strung on the brass rods, and all bolted securely together to form one continuous ring or cylinder. This ring must now be mounted on a hub, which in turn has to be fixed to the spindle, whilst space must be left between them for winding the coils of wire. This hub must be of brass or of gun-metal, and is generally cast in two parts in the form of two wheels with projecting spokes, and sold with the other castings for the machine. One with five spokes, to suit a ten-cogged armature, is shown at Fig. 44. Each arm must have a hole drilled in it as shown, to fit the ends of the brass rods running through the armature plates. The holes in the centre must also be bored true to fit a spindle, and a key-way cut in each. When bolting these spiders to the armature, care should be taken to gradually tighten all the nuts, and so bring the plates and the spider snugly and tightly together without straining the threads. This done, the surplus thread should be cut off with a hack-saw, and each nut secured with a touch of soft solder.

Preparing the Armature.—As the winding of a Pacinotti ring armature differs from that of the Siemens H armature, some special arrangements must be made for winding on the coils. Each space between the cogs will be filled with a coil of wire, which will be wound by passing one end of the wire through the space between the arms of the supporting spider and around the combined thickness of the laminations, as shown at Fig. 45. As the space inside is slightly less than that between the cogs, there is a danger of the inner part of one coil encroaching on the wire space of its neighbour. To prevent this, Mr. Crofts employs wooden guides fixed between the cogs on the outside, and secured to other wooden guides inside the armature by long thin screws passing through the ends, as shown at Fig. 45, and shown in section at A A, B B, Fig. 43. These effectually prevent slipping of the wire coils whilst the wire is being wound on, and can be moved from one space to another as the work proceeds.

I must leave details of winding and other matters relating to this machine to be dealt with in my next article, in which I also hope to treat of the Manchester and the Simplex dynamos as used for model electric lighting. Those of my readers who may wish for a more detailed account of how to make a Gramme machine will do well to invest 2s. in the purchase of a little book of 102 pages, on "How to Make a Dynamo," written by Mr. A. Crofts, 7, Clarendon Place, Dover. In the compass of these few pages Mr. Crofts gives concise directions for making a Gramme dynamo, from the rough castings up to the perfect finish of the machine. As it is clearly written and profusely illustrated, it forms the best book on the subject for the amateur electrician.

HINTS TO WATCH WEARERS, AMATEURS, AND OTHERS.

BY HERR SPRING.

A MOST important matter in connection with the time-keeping qualities of a watch is what is known technically as "positions." Comparatively few are acquainted with the influence which the position in which a watch is placed exercises on its time-keeping qualities. The two chief positions that a watch naturally occupies in its ordinary life are those of hanging and lying. A watch lies on the dressing-table at night, and stands upright in the waistcoat pocket during the day. It may be that it is also hung up at night, in which case it is practically always in one position. But I will now deal with the effects of the two positions: namely, hanging and lying. Generally speaking, all watches gain when lying, and lose when hanging: a fact which is due to the friction being less in one position than in the other. It is not on the whole of the mechanism that there is an appreciable change of friction, but only on the pivots of the staff or spindle of the balance or fly-wheel. The fly-wheel of a watch is so sensitive that the smallest imaginable cause affects it, and, therefore, affects the time-keeping of the instrument. Take your watch out of your pocket, open it, and hold it so that the movement is in the same position that it occupies when in your pocket. Then observe the fly-wheel. You will notice that the pivots of the balance-staff are resting in both the jewel holes, and that the fly-wheel is suspended pretty much in the same way as the wheel of a wheel-barrow is suspended when being worked. In other words, the sides of the pivots are resting against the sides of the holes, hence there is the friction of both pivots to account for. But now rest your watch on the table in a lying position, and you will see that the balance must now be resting on the extreme point of the bottom pivot, and is practically spinning on the point like a peg-top. True, the top pivot is still in the top hole, but there is very little friction to be feared, for the spinning motion tends to keep the top pivot in the centre of the hole, and perhaps it scarcely touches the sides. You will, therefore, see the great difference in friction that may exist between a watch hanging up and lying down. Probably you will be able to detect this for yourself. Place your watch in an upright position, and observe the action of the fly-wheel. Before you move the watch, note particularly the extent of the motion of the fly-wheel. Then lay the watch flat on the table, and again observe the action of the fly-wheel. Almost without exception, the change of positions makes a difference in the motion of the fly-wheel. In the hanging position, the motion of the fly-wheel becomes small—or "drops off," as the technical phrase has it. In the lying position the motion of the fly-wheel increases. In very common watches this difference of motion in the two positions is sometimes enormous, but in very fine watches it is often scarcely appreciable. But where this does exist in a large degree, no good time-keeping can be relied on. This defect, even in the most perfect watch, can never be completely eradicated; but in very high-class watches, after everything has been done to equalise the friction of the fly-wheel pivots, the error in time-keeping can be corrected, in a large degree, by means of isochronisation. At the present, however, I am dealing with the average class of watches generally in use, and in this class there is usually a large degree of error in the two positions. I will now address myself to an imaginary country watchmaker, who knows how to take a watch to pieces and put it together again, and, perhaps, to execute a few repairs, but whose theoretical knowledge is limited, owing to the lack of opportunity. It is convenient for me to adopt this plan because my remarks will at the same time be, to a large extent, intelligible among amateurs and watch wearers. Let us suppose that some client, more particular than the general run of wearers, brings his watch to the country watchmaker, and complains that it *will not* go evenly, although he has "had it at many watchmakers." Now, a highly trained mechanic, like a highly trained physician, would probably diagnose such a watch almost at a glance. He would in a moment detect where the watch was made, make a shrewd guess at its age, perceive to what extent it had suffered at the hands of rough workmen, and probably pick out a leading fault, which would at once start a train of reasoning in his mind, leading up to some trouble in a hidden and unexpected part of the watch. But I am writing now for the benefit of those who are not capable of making a diagnosis of this sort, and such men have frequently to deal with watches which, while performing fairly well in an ordinary way, and never stopping, still give no great satisfaction. In such cases I would advise the country watchmaker, if he is ambitious to improve himself and to overcome difficulties, to try the watch in positions. But, first of all, he must see that the fly-wheel has a good motion—for it is of no use to attempt to obtain good results unless there is a good swing with the fly-wheel. A man suffering with the headache cannot be expected to do good mental work, nor can a watch with a poor motion be counted on to keep good time. Both are indicative of some interior trouble, which should be removed. Supposing, however, there is a fairly good action with the fly-wheel, and still the time-keeping is erratic. What is to be done? Let the country watchmaker wind the watch to the top (that is important), set the seconds hand exactly with the hand of a reliable regulator clock, and then lay the watch on its back, and allow it to remain thus for, say, eight hours, when it is again to be compared (the seconds hand of both watch and regulator to be at the 60, both when *set* and *compared*). He must make a note when he sets the watch and when he compares it, and mark down the result. Let us suppose that the watch has gained twenty seconds during the time, in which case his note would read as follows—although he can use any form of note which is intelligible to himself:—

Lying: Watch set at 9·30.
To be compared at 5·30.
Result in eight hours—Fast, 20 seconds.

The next day he must wind the wat

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the top, and having set it with the regulator clock, *hang it up* for eight hours, and then compare it. Let us assume that, in hanging, the watch has lost ten seconds, making a net variation of thirty seconds in eight hours in two positions. Of course, with such an error as this no watch could be expected to give satisfaction. Hence we must go to work to cure it. The first thing to be done is to try the shake of the lever on the banking pins. If they are too wide they must be closed a little. If the escapement appears to be a square and well-finished one, the bankings may be closer than if the escapement is a rough and clumsy one. But only practical experience can tell the precise shake required on the bankings. One good test is this: close the bankings until the lever has no shake, but is just free, then if the watch goes with the pins so close, you will be safe in giving but little shake. But do not forget that the shake of the bankings alters a little with the position of the watch—if it be lying on its back, on its face, or hanging. Therefore a shade of allowance must be made for this. Next try the curb pins, between which the hair-spring works. Move the index slowly round while the balance is at perfect rest. As you move the index, observe, with a very strong glass, if the spring always remains in the centre. If not, you must bend the spring until you can move the index from one side of the cock to another without the pins

Fig. 1.—Straight cut Jewel Hole.

Fig. 2.—Rounded Jewel Hole.

unduly pressing on the spring while they are being moved. The reason for this is important. If you get your watch right in positions, and your index does not work in perfect circle, when you come to move the index, the curb pins, by pressing too much on one side of the spring or the other, would tend to destroy the adjustment. After this, take your balance out, and very carefully poise it. The poising is of vital importance. But you cannot poise accurately with the calipers. You must obtain a small poising table with two knife edges upon which to rest the tip of the pivots. Do not move the balance, when on the poising table, with any instrument; simply blow gently on it till it moves, and wait till the heaviest portion of the rim falls to the bottom (I am using the word "balance" now in place of "fly-wheel"). After you have poised the balance, carefully examine the pivots and also the two jewel holes. Very often the secret is to be found here. In ordinary watches the holes are, as a rule, too long and straight, with the result that the pivots have too much of the surface of the hole to work upon when in a hanging position. Hence, there is so much friction, that, in hanging, the watch goes slow. It is a good thing for the hole to be long—the longer the better, because there is then room for the oil. But when the hole is long and straight the friction is dreadful. Now, in the case of the watch which we are experimenting on, if the jewel holes are at all straight they must be altered. In any case, send them to the nearest jeweller, if necessary, by post, and ask him to polish the holes up a little inside, and, if need be, round them up. If you have a very strong glass—and you should have one in stock—you will in all probability find the holes like Fig. 1, whereas they should be like Fig. 2.

In Fig. 2 you have all the advantages of length and strength in the jewel hole combined with the minimum of friction, and it often happens that this alteration in shape, which the jeweller will do for you, reduces the error in positions most materially. Finally, have the balance pivots "touched up" nicely with a fine burnisher; examine the lever-notch, and, if rough, have that carefully burnished with a fine burnisher shaped for the purpose. Having done all this, put the watch together again, and try it hanging and lying for eight hours each way. We will suppose that the error in positions has been reduced from thirty seconds to fifteen seconds, and that so far a great victory has been achieved. In my next contribution I will deal with the remaining error.

A CABINET PHOTOGRAPH FRAME.

BY OMADAUN.

THE crescent moon has been used for decorative purposes in so many different ways that I almost hesitate to claim for my adaption of it the charm of novelty; yet so far as I am aware it is a conception of my own, and whether the actual design be novel or not, I think the frame as a whole will be new to most of my readers.

It is not possible to convey an adequate idea of its effect by means of an engraving, as it owes so much of its charm to the colour and materials used, in which, as it will be seen, there is considerable scope for variety, and I have not, therefore, attempted to give a sketch of the complete article, but a general idea of it can be obtained from the diagrams given to explain the construction, when I say that the crescent is painted or enamelled, and the mount covered with plush, the colours of course harmonising. I have used a pale "electric" blue plush, and lemon yellow for the crescent, which looks very well; but individual taste will differ, and various other combinations of colour will readily suggest themselves. The frame might look very well too I think if the crescent were gilded or bronzed with one of the various coloured bronze powders that can be obtained, but in any case the construction, which I will now explain, will be the same. It will be best perhaps to begin with the mount. For this we shall require a circle of wood which should be about $\frac{3}{16}$ of an inch thick (Fig. 1), and a similar one of stout cardboard (Fig. 2). The former has a piece cut out of it sufficiently large to take a cabinet photograph, an oval of the usual size being cut in the card mount, so that when the two are placed together with the openings coinciding, we have a rebated frame as shown by the dotted lines in Fig. 2, in which a glass and photograph can be fixed in the usual way.

One side of the wooden mount should now be covered with some tinted or plain white paper, which must be cut sufficiently large to admit of its being turned over the edge all round, the paper being also cut out and turned over the edge of the opening. The card mount has next to be covered with plush, the material being carefully and evenly turned over the edges in the same manner; the two mounts can then be glued together back to back, and left to set whilst we turn our attention to making the crescent.

The shape of this is shown by the dotted lines in Fig. 1. It will be seen that it is cut

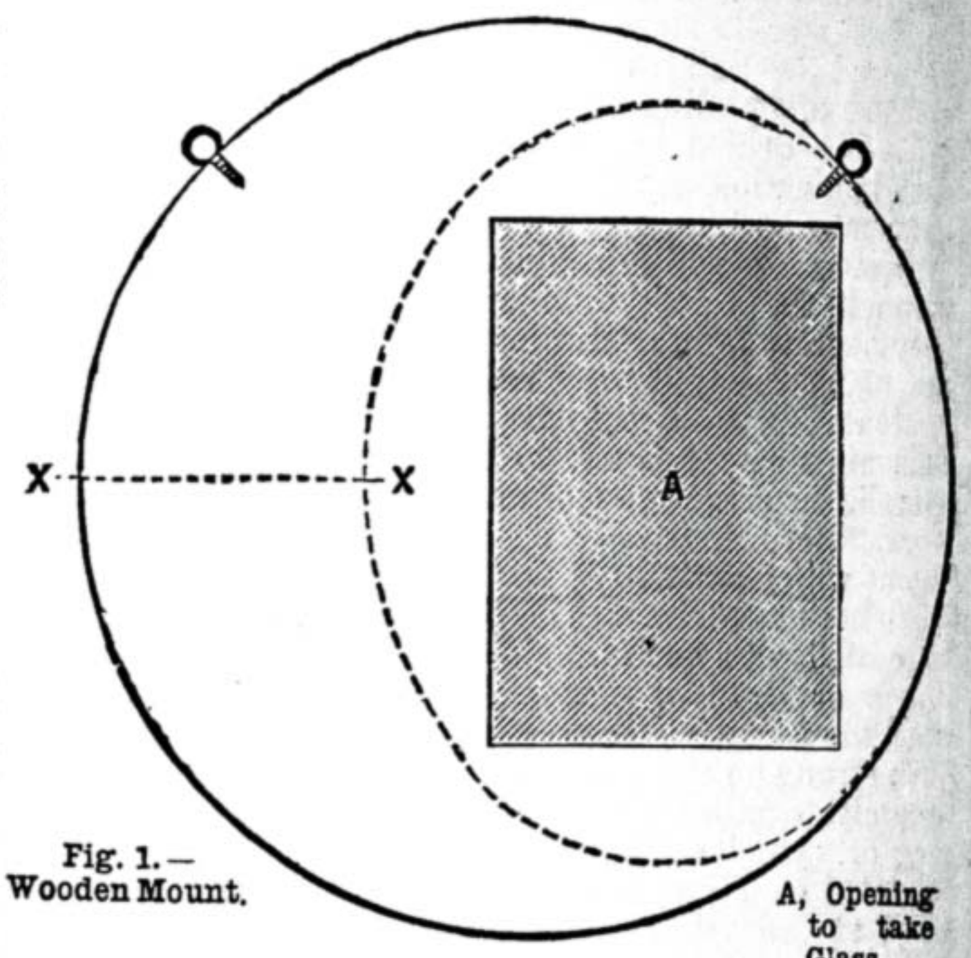

Fig. 1.—Wooden Mount. A, Opening to take Glass.

in such a way as to leave the exposed part of the mount in the shape of an oval, in the centre of which is the photograph. It is very essential that there should be an *equal* margin round the inner oval, so that care must be taken to get the crescent cut out correctly, and it will be found by far the best plan to make a full-sized drawing to work from. It should not be more than $\frac{1}{8}$ of an inch thick, and should be cut out with a fret saw from a piece of pine which must be free from knots, the wood having been previously planed and sand-papered. It is well to have the grain *across* the crescent, by which I mean that it should run between the two points marked X in Fig. 1, so as to have it running *with* the points as much as possible, as if running across them from top to bottom they will be very likely to get fractured during the progress of manufacture; when mounted, they will of course be protected.

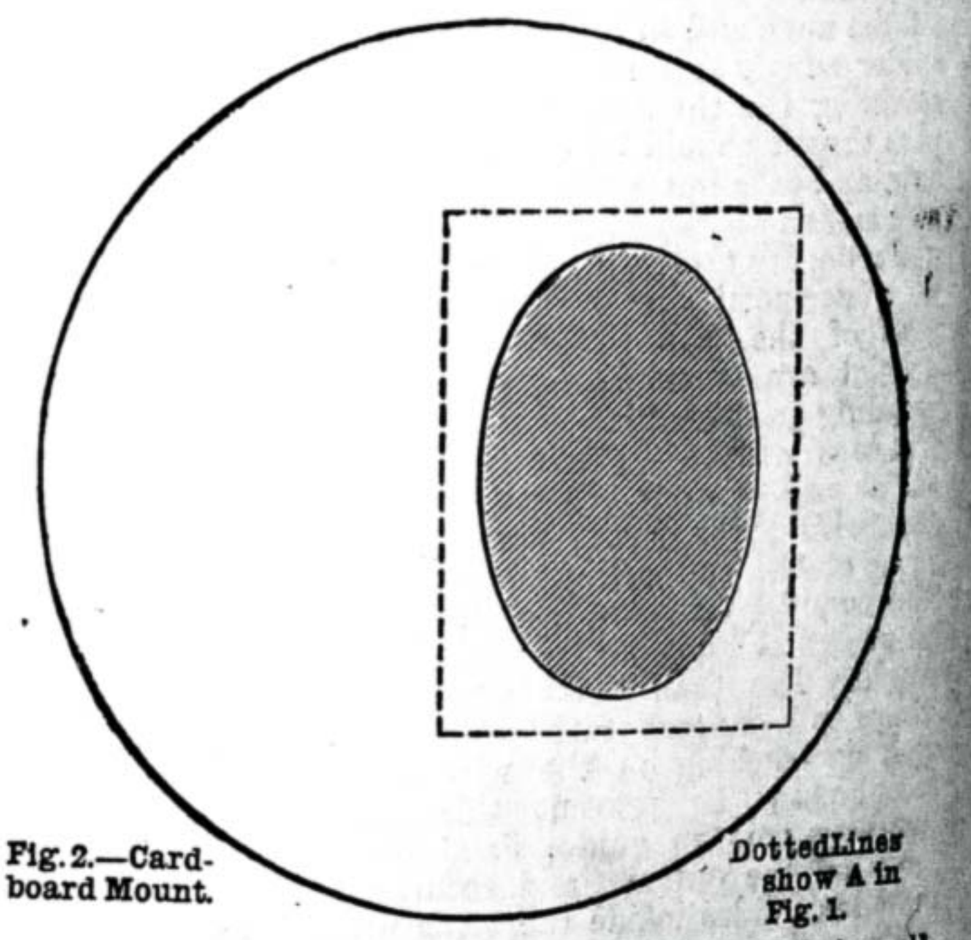

Fig. 2.—Cardboard Mount. Dotted Lines show A in Fig. 1.

The crescent has now to be enamelled. This sounds easy enough, and indeed is so if a little care is taken, but the enamelling or so called "Aspinalling" that I have sometimes

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seen, makes me think that a few words of advice may not be out of place. To get a really good surface it will be necessary to give it at least three or four coats of the enamel, always letting one coat get *thoroughly* dry before attempting to put on the next. The surface should be rubbed down quite smooth between each coat, either with fine well-worn sand-paper, or with pumice-stone and water; the latter being first ground upon a wet flagstone to get a flat surface to work with. The last time, *i.e.*, before putting on the final coat, only just the gloss should be taken off, being careful not to make any scratches; by this means a smooth and even surface should be obtained. If it is intended to use bronze, a coat of the enamel should first be given, or even two, the bronze powder being dusted on with a camel-hair brush or pad of wadding when it is just "tacky."

All that now remains to be done is to glue the crescent in its place upon the plush mount. Be careful to get it set straight with the inner oval by trying it first and sticking a pin in the mount at each of the points; there will be no difficulty then in replacing and gluing it in position. Two eyes should be screwed into the edge of the wood at the back, by which the frame can be hung up.

The crescent might have a flower or small view painted upon it, or even a "Japanese" insect might be used; no doubt a painting would materially add to its effect, and if the trouble of enamelling is objected to, an alternative plan would be to use some ornamental wood, such as holly for instance, which could be left in its natural state. The diagrams given are drawn one-quarter size, the frame being intended for a cabinet photograph; they might, of course, be made for cartes-de-visite, but I think they would hardly be as effective on so small a scale.

MICROSCOPICAL WORK.

BY J. P. S.

MICROSCOPES are now so easily procurable at a cheap rate, that it is thought the following *wrinkles* on the preparation, etc., of specimens to be viewed under them may be of use to our readers.

Such objects are of two kinds as regards their optical properties—opaque and translucent. Many objects which in a state of nature are transparent can, however, be made objects of microscopic research by means of stains, of the use of which more anon. I intend in this article to treat only of botanical specimens. These are as a rule translucent—that is, they are viewed by means of light which is reflected from the mirror of the microscope, and then passes through the object to the eye of the observer. In order that the mounts may be a success, the specimens must be carefully prepared and handled.

As a preliminary, we may give a list of the materials which are required. The list does not pretend to be a complete one, but nevertheless it is one which will be found useful by the ordinary observer.

A good hollow ground razor, 3s. 6d.; two needles in handles; glass slides, 3 in. by 1 in.; one box of glass cover-slips, two camel-hair brushes, medium size; elder-tree pith; glass rods, 3 to 6 in. in length, about ⅛ in. in thickness, and sharp-pointed. A copper lifter (spatula); methylated spirit, 30 per cent., 60 per cent., and of ordinary strength; absolute alcohol; clove oil; Canada balsam dissolved in benzine; benzine; caustic potash (KOH), 1 to 5 per cent.; acetic acid, 1 per cent.; glycerine, 50 per cent. in water; glycerine jelly; olive oil, containing a very small quantity of carbolic acid; distilled water; and the following stains: aniline dyes, such as magenta and carmine, hæmatoxylin (logwood), Schultze's solution (chlor-zinc-iodine); iodine; methyl-green, etc.; a turn-table; a cabinet to hold slides—this may be made either of pine-wood or paste-board. All the above may be obtained from the dealer's. The stains are, as a rule, sold in bottles, varying in price from 6d. to 1s. The different percentages of methylated spirit can easily be made up from the ordinary methylated spirit sold in shops by

Fig. 4.

Fig. 1.

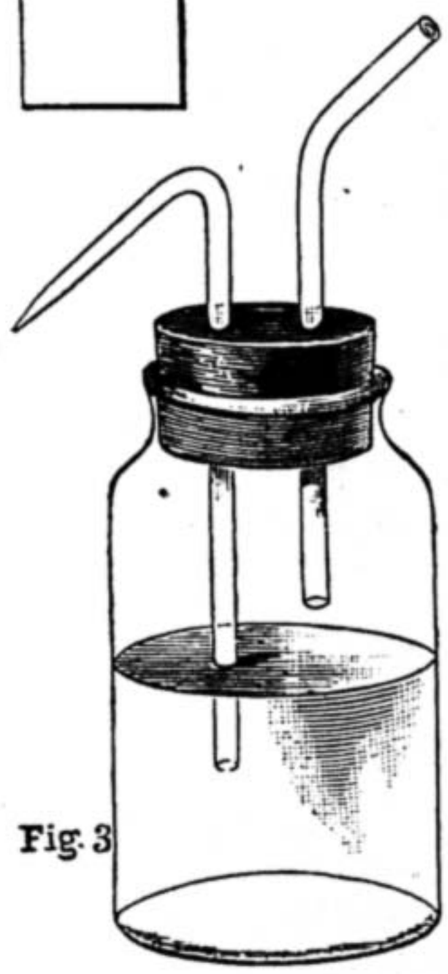

Fig. 3

Fig. 2.

Fig. 1.—Bottle and Rod for Caustic Potash, etc. Fig. 2.—Ditto for Canada Balsam. Fig. 3.—Ditto for Methylated Spirit. Fig. 4.—Mode of mounting Specimen.

means of a graduated flask. These should all be kept well corked and carefully labelled. Bore a hole through the corks of the bottles containing the stains, caustic potash, glycerine, and glycerine jelly, and insert in each a glass rod. The size of the rod used will vary with the size of the bottle (see Fig. 1). The balsam should be put into a bottle having a ground glass stopper, and fitted to the bottle as in the diagram (see Fig. 2). It is convenient to put the methylated spirit in a bottle fitted up thus: select a bottle having a wide mouth; fit with an ordinary cork, in which bore two holes. In one hole place a glass tube bent at an obtuse angle; into the other insert a glass tube at an angle of 45° (see Fig. 3), and drawn to a point.

We are now in a position to commence work. Our method of procedure will be determined by the character of the specimen which we wish to mount. Suppose, for instance, we wish to make a transverse section of the stem of an herbaceous plant about ½ in. thick. Take a piece 1 in. or so in length; hold it in a vertical position in the left hand. Take the razor in the right hand, and blow some 60 per cent. of alcohol on the blade out of the wash-bottle; then cut the stem across at an angle of 90° with the vertical. The first section or two will not be of much use, but if care be taken the rest ought to be of such thinness as to warrant further trouble being taken with them. In cutting, draw the razor in a sliding manner from the heel to the tip of the blade; then take the section off the razor by means of a camel-hair brush, and place it in a watch-glass containing water (if the specimen is to be mounted in glycerine or glycerine jelly), and into one containing methylated spirit if it is to be mounted in Canada balsam. Always keep the razor wet with 60 per cent. alcohol.

When a thin object like the leaf of a plant, or a small object like an ovule, has to be cut, it is necessary to have some means of holding it. This is accomplished by making a slit in a piece of elder-pith, and inserting the specimen therein. Then pinch the slit portion tightly, and cut pith and specimen with the razor in the manner directed above.

It is sometimes unnecessary to cut the specimen into thin slices. If the epidermis, or outer covering, of a leaf, for instance, is to be examined, the leaf is placed in KOH for a short time, say a few hours, then wrapped round the first finger of the left hand, upper or lower, surface upward, as the case may be. After this, a slit is made by means of a sharp knife along the mid-rib, and the skin peeled gently off, from the mid-rib outwards.

There are three media in which botanists as a rule mount their objects. These are glycerine, glycerine jelly, and Canada balsam. To these may be added a third—acetic acid 1 per cent. We will proceed to consider in detail the processes that an object must go through before it can be considered ready for mounting in either of these. In the first place, we may remark that caustic potash and "eau-de-javelle" are used as clearers for those about to be mounted in glycerine, glycerine jelly, or acetic acid.

"Cleanliness is next to godliness" is an old saying which finds practical application here. Unless you keep your slides, cover-slips, and in fact all the paraphernalia of mounting, absolutely clean, your specimens will be spoiled as objects of microscopic research—which misfortune will not put you in a sweet temper, especially if elaborate preparations for mounting in Canada balsam have been completed.

1. *Mounting in Glycerine, or in Glycerine Jelly.*—The advantage of the use of glycerine is that it does not easily evaporate, and has a high refractive index. Objects which have been stained in carmine, hæmatoxylin dissolved in ammonia, or with aniline colours, also those cleared by caustic potash, etc., may be at once mounted in glycerine. Thoroughly clean your glass slide, and dry it with a linen duster. Then clean a cover-slip in the following manner: take the slip edgewise between the thumb and middle finger of the left hand; breathe gently on both sides of it, and rub it up with an old fine linen or silk handkerchief held between the thumb and middle finger of the right hand, being careful to keep the tips of the fingers always opposite one another, otherwise the thin glass will easily be broken in the process. When the cover-slip is clean lean it against some object; never place it flat on the table.

We are now in a position to proceed with the permanent mounting of the specimen. Place it in the centre of the slide and keep it

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wet, otherwise air-bubbles will be sure to make their appearance. Should these be present, they can easily be got rid of by placing a little methylated spirit on the specimen. This operation may have to be repeated three or four times before the air-bubbles have quite disappeared. It is very important to get rid of them at this stage, especially if you are about to use glycerine as the mounting medium. The presence of air-bubbles has ruined many an otherwise fine specimen. We will suppose then that they are now conspicuous by their absence. Place two or three drops of glycerine on the top of the object by means of a glass rod; take the cover-glass *edgewise* in your left hand and a needle in your right. Adjust the edge of the cover-glass on the slide in a position near the specimen, and gently lower the glass with the aid of the needle on to the top of it. We say *gently*, because if done rapidly air-bubbles would probably appear. The specimen thus mounted will keep a very long time, but the cover-glass is apt to slip out of its place and leave it lying exposed on the top of the slide. It is advisable then to "ring" it. Clean off by means of blotting-paper any glycerine which may be on the slide outside the cover-slip. Fasten the slide to the brass disc of the turn-table by means of the clamps. Now see that the circumference of the cover-glass corresponds in position to that occupied by one of the concentric circles on the brass disc. Dip a camel-hair brush in the zinc white, hold the brush in the right hand, rest the hand on the turn-table, and cause the brass disc to revolve by turning the screw placed beneath it for that purpose. Do not turn it too quickly at first. While the ring is revolving, lower the brush in such a manner as to cause it to touch at once the slide and edge of the cover-slip. This must be done gently, as the cover-slip is apt to shift out of its place. A ring of cement will now be left round the object which will firmly fix the cover-slip to the side. The operation must be repeated next day or the day after, in order to make sure that the object and its surroundings are perfectly air-tight, else the glycerine will ooze out, and your work will have been of no avail.

Glycerine jelly is a mounting medium preferable to glycerine, because it hardens, and the mounts may then be kept without ringing any length of time, provided they are laid in a dry place. Raise up the cork of the bottle containing the jelly, and then place the bottle by degrees up to the neck in a vessel of boiling water. When the jelly has thoroughly melted, mount the object in it in the same manner as described for mounting in glycerine. Should air-bubbles be in the specimen after it is mounted, they may be got rid of by the following means, devised by Dr. Wilson, of St. Andrew's University. Heat the mount gently over a spirit-lamp until the jelly begins to boil, then rub the slide firmly over a *cold* glass surface. The contraction of the jelly, due to the sudden cooling, forces out as a rule the whole of the air-bubbles. The only disadvantage to this rather rough-and-ready method of procedure is that it cannot be applied to delicate structures. Allow the jelly to stiffen, clean off any superfluous material, and ring the slide as before. If, as stated above, the slide be kept in a dry place, it need not be rung at all.

2. *Mounting in Canada Balsam.*—This is the most complicated method of mounting, but the results obtained, we think, amply repay any trouble entailed. The object must in the first place be thoroughly soaked in methylated spirit, and then be well saturated in absolute alcohol. The absolute alcohol removes all traces of water which were in the methylated spirits. Clove-oil is the next substance to which it must be transferred. Here a remarkable change will be noted; the absolute alcohol is driven out, and the object becomes almost transparent. The methylated spirit, absolute alcohol, and oil of cloves should each be poured into a watch-glass. The specimen is placed in the watch-glass containing the methylated spirit, and when it is thought that the alcohol has had time to penetrate the whole of its tissues it is transferred to the absolute alcohol. Absolute alcohol is a somewhat expensive material, and evaporates readily, so place a cover over the vessel containing it, and always keep your supply in a well-stoppered bottle. When the absolute alcohol has taken the place of the methylated spirit—the time occupied by this process varying with the thickness of the object—transfer the object to the watch-glass containing oil of cloves. The transferences should always be done by means of a carefully cleaned camel-hair brush, especially if the specimen be a delicate one; if it be a coarse one, a needle or spatula may be used. The clearing process now undergone by the specimen renders it necessary that it should have been well stained before being put into the methylated spirit. After the oil of cloves has thoroughly taken possession of the object it is ready for mounting. Place it in the centre of the slide as formerly, and place gently a drop or two of Canada balsam on it, being careful about the presence of air-bubbles. These can, as a rule, be easily expelled by placing the slide in a water-bath or by heating it *gently* over a spirit-lamp. At the same time, the balsam hardens to such a degree that there is no necessity for "ringing" it. Should you wish, however, to make it appear neat, clean off the superfluous balsam, *after it has thoroughly hardened*, first by means of a knife, and then by using a cloth soaked in benzine. Now put a ring of gold size round the edge of the cover-glass, and then when this is dry ring as before. It must be well noted that the ring of zinc white must not be put on immediately after cleaning off the superfluous balsam: the result would be disastrous; the Canada balsam and zinc white are both dissolved in benzine, consequently they would mix, and so ruin the specimen.

3. *Mounting in Acetic Acid* (1 per cent.).—First ring the slide with zinc white, making a ring of such dimensions that its outer edge would come a little outside the edge of a cover-glass. When dry, place a drop or two of acetic acid in the cell thus formed, and transfer the object to it. Then lower the cover-glass on the top of it, wipe off with blotting-paper the acid outside the cover-glass, and ring as formerly. The superfluous acid is best dried off by using a piece of blotting-paper the size of the slide, and placing it flat on it. Be sure not to have air-bubbles in the cell. If the preparation be one of the green parts of plants, and it be wished to retain the chlorophyll, this method of mounting will be found very useful.

Now a few general hints as to the methods of procedure noted above. Always keep the razor and specimen wet with weak alcohol or water. Alcohol dissolves chlorophyll, so do not put a specimen in which it is desired to retain the whole of the chlorophyll among alcohol. If the presence of starch is to be detected, use a dilute solution of iodine. Iodine turns starch blue. Label a slide before putting it away. Supposing the specimen were a transverse section of the stem of *Ranunculus aquatilis*, you would label it as in the diagram (see Fig. 4), in which T. S. denotes transverse section, and B Canada balsam, the supposed mounting medium.

OUR GUIDE TO GOOD THINGS.

*** *Patentees, manufacturers, and dealers generally are requested to send prospectuses, bills, etc., of their specialities in tools, machinery, and workshop appliances to the Editor of* WORK *for notice in "Our Guide to Good Things." It is desirable that specimens should be sent for examination and testing in all cases when this can be done without inconvenience. Specimens thus received will be returned at the earliest opportunity. It must be understood that everything which is noticed, is noticed on its merits only, and that, as it is in the power of anyone who has a useful article for sale to obtain mention of it in this department of* WORK *without charge, the notices given partake in no way of the nature of advertisements.*

110.—ASHLEY'S "CELUZON."

THE material to which Messrs. Ashley & Company, Crossgates, near Leeds, have given the name of "Celuzon," and which is manufactured by them, is a recently discovered composition for the bleaching, cleaning, and polishing pianoforte keys of celluloid, xylonite, and ivory. It is also effective in removing the gum that arises from the wood after being newly French polished, previous to using the reviver. "Celuzon" itself is in the form of a tablet, and resembles a small cake of soap, although it is of far greater density than that cleansing material; and though I do not for a moment pretend to say that this is its actual composition, it seems to consist of some highly levigated material, such as clay mixed with and held together by some saponaceous matter. Pianoforte keys of celluloid or xylonite, being composition, show scratches, and turn yellow much quicker than ivory keys; they are also subject to discoloration from perspiration of the fingers. Such keys should never be scraped on account of their thinness. In order to restore their pristine colour and to polish them at the same time, all that is necessary is to rub the key briskly from end to end, after its removal from the pianoforte, with a block of wood covered with leather, which must be damped and rubbed over with "Celuzon" before using it. As the work is so simple, it can be done by a boy or girl. Ivory keys are cleaned in the same way, if they are not much discoloured, but if very yellow with age they should be first scraped. For removing the gum or dulness that generally shows itself on all wood that has been newly French polished, all that has to be done is to scour it off by means of a piece of flannel damped and rubbed on the "Celuzon"; then apply a reviver, and the wood will appear as if newly French polished. Thus it is useful for renovating the polish of the wood case of a pianoforte as well as the keys. "Celuzon" is sold in tablets at 3d. singly, or at 2s. per dozen, or 18s. per gross.

SHOP:

A CORNER FOR THOSE WHO WANT TO TALK IT.

*** *In consequence of the great pressure upon the "Shop" columns of* WORK, *contributors are requested to be brief and concise in all future questions and replies.*

In answering any of the "Questions submitted to Correspondents," or in referring to anything that has appeared in "Shop," writers are requested to refer to the number and page of number of WORK *in which the subject under consideration appeared, and to give the heading of the paragraph to which reference is made, and the initials and place of residence, or the nom-de-plume, of the writer by whom the question has been asked or to whom a reply has been already given. Answers cannot be given to questions which do not bear on subjects that fairly come within the scope of the Magazine.*

I.—LETTERS FROM CORRESPONDENTS.

Articles in WORK.—G. W. S. (*Stockport*).—A post-card has been handed to me, addressed by you to Mr. J. W. Harland, asking him if he can put articles in WORK on "Portrait or Landscape Painting" and "Heraldic Painting on Carriages,"

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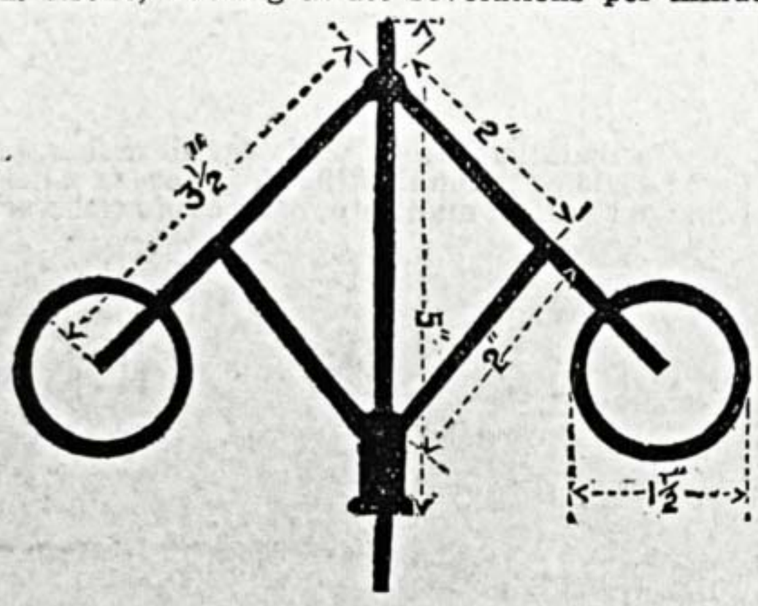
and, if so, if he will do so as soon as possible. As I find from various letters that many seem to be under the impression that Mr. Harland's functions are editorial, let me at once remove this idea from the minds of all readers of WORK by saying that Mr. Harland's duties are simply those of secretary to the "Work" Exhibition, and that the editorial management of WORK, including the introduction of particular subjects, and the acceptance or refusal of papers sent on approval, rests entirely in the hands of THE EDITOR.

Governor for Half Horse-Power Engine.—J. M. P. (*Nottingham*) writes:—"In WORK, Vol. II., page 294, F. A. M. gives your correspondent W. W. (*Glasgow*) dimensions for a governor. Now, whilst agreeing with much that F. A. M. writes, I must say that his dimensions are too large for this sized engine. I was troubled in the same way as W. W., and could not get any proper dimensions, so set to work and experimented till I found one suitable. My engine is 2½ in. bore, 4 in. stroke, running at 200 revolutions per minute



Engine Governor.

at 40 lb. pressure. I enclose sketch showing measurements, which I have found suitable, and may say that my governor controls the engine immediately there is any variation of load or beam. It runs at a speed of 100 revolutions per minute, and develops a surprising amount of power. I do not think my engine varies so much as ten revolutions per minute, which I should take as a large amount of variation, and one that would cause irregular running. I can assure W. W. that he will be satisfied with this governor."

Weighing Machine.—ERRATUM.—In this reply (see page 618, Vol. II.), for "out" read *all*.

II.—QUESTIONS ANSWERED BY EDITOR AND STAFF.

Condensers.—J. H. H. (*Belfast*).—The lantern described is intended to be fitted with 4 in. condensers. You will, therefore, find it quite correct to follow the dimensions given. The condensers are not to be fitted into the woodwork, as you appear to imagine, but they are fitted to a collar attached to the metal stage-plate of the lantern front, as you will find by referring to the description of the instrument on page 494, No. 83 of WORK. The openings in the woodwork must naturally be larger than the condenser, as they require to take the lens and its containing collar.—C. H. P.

Decomposition of Water.—H. T. M. (*Harwich*).—This is impracticable, owing to the high resistance offered by water. The experiment you mention is performed with a dilute solution of sulphuric acid electrolysed with a current of from four to six volts. Three Bunsen or bichromate cells arranged in series will provide sufficient E.M.F.—G. E. B.

Picture Frames.—AMATEUR.—For making compo. for picture frames, etc.:—To a stone of whiting take 7 lb. of resin, 7 lb. of glue, 1 quart of raw linseed-oil, 3 lb. of pitch; boil together in a large iron cauldron for three hours, then mix together with dry whiting (crushed); well knead it together upon a board; it will then be ready for your moulds, and will keep for months.—G. C. R.

Circular Saw.—H. G. (*Little Bolton*).—I know of no book treating on the practical working of the circular saw, but you can get books on woodworking machinery, published at 13s. and 25s. each (in which there may be some useful information in reference to the working of saws), of William Rider and Sons, 14, Bartholomew Close, London. There is a deal of information in back numbers of WORK.—A. R.

Mounts.—W. G. J. (*Portsmouth*).—For cutting card mounts for pictures, see "Shop," August 10, 1889, page 333, and again December 28, 1889, page 652. Tools are only knife-blades specially made for this trade, and shaped like a harpoon, both edges sharp; cost 1s., of any first-class tool maker; a screw-handle for about 2s. 6d.—G. C. R.

Book on Electro-Plating.—ARGENT (*Pendleton*).—Messrs. Crosby Lockwood & Co., London, publish a book on "Electro-Plating," by Mr. J. W. Urquhart; the price is 5s. Messrs. Whittaker & Co., 2, White Hart Street, Paternoster Square, London, E.C., have a book in the press that will just suit your purpose. It is named the "Electro-Plater's Handbook," and will be published at a low price, say 3s. or 3s. 6d., to suit amateurs. I am also preparing some articles on "Gilding and Silver-Plating Jewellery," and these will probably be published in WORK.—G. E. B.

Polishing.—JEAN.—In all probability your piano requires repolishing. It is not at all an uncommon occurrence for new polish to go more or less. The defect is frequently owing to what is known as "sweating"—*i.e.*, the oil in the wood exudes through the thin coating of polish, and by dust adhering to it the surface presents a reticulated appearance, being covered with fine dull thin lines. This sweating is to a great extent unavoidable, and Burr walnut is specially liable to it. If this is all that is the matter with your piano, you may be able to put it right by washing off the sweat with warm water; or, better still, with a reviver composed of linseed-oil, French polish, and vinegar. If all the polish has gone, there is no alternative but to repolish. If your piano is one of the low-priced Continental ones, and has not been repolished by the vendors here, very probably the polish has perished. I have often noticed on goods of this class that, though the polish while they are new is very brilliant, it does not last, there being apparently no body to it. You must not take any of these remarks as implying that the vendor is any way to blame. Read the article entitled "Hints on Repairing Furniture," which appeared in No. 93 of WORK, page 658.—D. D.

Patent—Altering Specification.—H. R. (*Paddington*).—Assuming that the two materials are merely for convenience of manufacture, and are not an essential part of the invention, we see no reason why H. R. should not use the one only, for the invention will then continue to be "substantially the same." In his complete specification, he can say that "by preference" he makes use of one material only. In our illustration of the wheelbarrow to which he alludes, the essential part is the use of the single wheel for removing burdens, and the thing will be substantially the same whether the barrow be made of wood or metal. We are presuming that the subject of our correspondent's patent is a mechanical invention, for if, instead, it were some chemical compound, the materials would probably be the essential part, and to change them would be to cause a "substantial" difference. H. R. may find assurance in the reflection that a main object of provisional protection is to enable the inventor to perfect his invention, and completely to ascertain its nature, and how it may best be carried out.—C. C. C.

Chimney Pot.—J. L. (*Guernsey*).—If your fire will not burn properly without a revolving top, you can get one made fireproof at an extra cost of 5s. to 10s. They are made of strong galvanised iron or steel, with riveted joints, or in case of very intense heat copper could be used, but this would be very expensive. Makers are Gibbs & Son, Liverpool; Boyle & Son, London; Kite & Co., London; and many others. You will probably get them through a local ironmonger, but are you quite sure a revolving top is needed? as I had a similar chimney with a revolving top, and on account of it getting stopped with soot, I tried the fire without it, and except in a severe gale it burns as well without the revolving top. You might try yours, and if it burns anything like without the revolving top, fix a fire-brick pot, of which I send two designs made for exposed

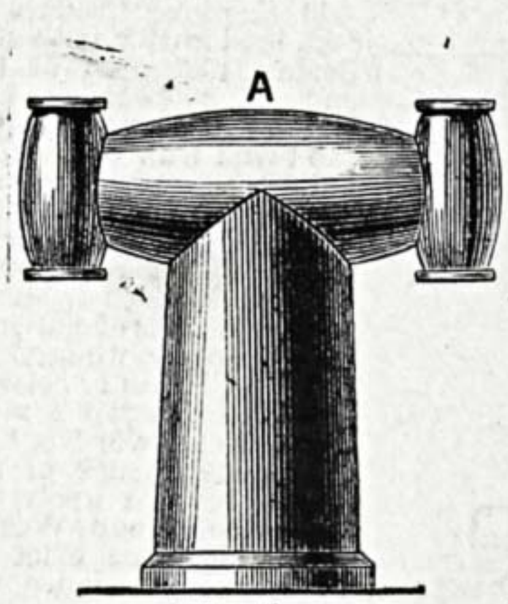


Fig. 1.

Fig. 2.

Fire-Clay Chimney Pots for Exposed Situations—A, Wind Guard.

situations; I should recommend Fig. 2; they can be obtained from a dealer in builders' materials. If your chimney has only one flue, and is high and detached from the building, you should stay it by iron rods to the nearest wall or roof, or it may blow down with a heavy pot on the top.—M.

Winding Model Gramme Dynamo.—C. B. (*Chapel-en-le-Frith*).—Very little in the way of electric lighting can be done with such a small machine as that of which you send a sketch. It is a model of a Gramme dynamo. On the small cogged armature of 2¼ in. by 1½ in., with gaps between the cogs measuring ¼ in. by $\frac{11}{16}$ in., you will only be able to get forty-two yards of No. 24 silk-covered wire (weighing about ¼ lb.), as this will have to be wound in seven coils, and as only half of each coil can be reckoned upon as being efficient, you can only expect an E.M.F. of three volts from the machine when driven at a speed of 3,000 revolutions per minute. As No. 24 wire will only safely carry one ampère of current, you must choose a lamp of low resistance, such as a small pea lamp, requiring a current of less than one ampère, and this will give a mere spark of light. Do not mount the armature on a wooden hub, or it will soon shake loose, but mount it between two "three arm" brass spiders secured by studs to the cogs of the armature. Wind as much No. 24 wire on the armature as you can get on, and put 1 lb. of No. 24 on each core of the field magnets.—G. E. B.

Lathes and Smithing.—G. W. (*Brockley*).—All branches of smithing and lathe matters will be treated in course of time in WORK.

Marbling.—W. H. (*Benzon St.*).—You should obtain "The Whole Art of Marbling as Applied to Paper, Book Edges," etc., by C. W. Woolnough, 10s. 6d.; Bell & Sons, York Street, Covent Garden, London.—K.

Photo Tent.—R. H. (*Bradford*).—There are tents and tents. As to their construction, very much depends on the use to be made of them. In the wet collodion days they were portable laboratories of considerable weight, now they are seldom used except for the purpose of changing plates, and are, as a matter of course, very much slighter

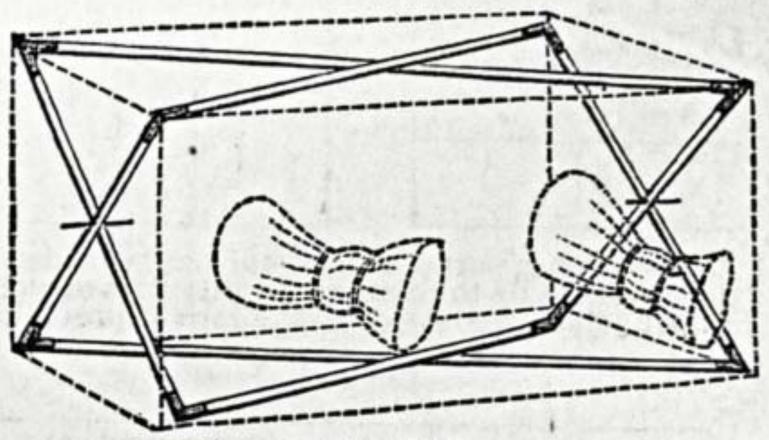


Photo Tent.

in make. A square or oblong bag of black and yellow twill, with sleeves, and distended with bamboo rods, is an efficient and light apparatus, one sleeve being of sufficient width to allow the dark slide to be passed inside; and the changing of the plates is effected by feel only, easily done with a little practice. The sleeves are constructed in two places a few inches apart, with indiarubber bands to prevent access of light. The framework consists of two end pieces, straight pieces of bamboo, crossed and riveted through, that can be folded parallel when not in use; four other pieces the length of the bag are fitted into sockets at each end of the cross-pieces, and when in place extend the bag to its utmost dimensions. When not in use, it rolls up together in a small compass, and is most convenient for travelling. The accompanying diagram will explain. The dotted lines show the bag and sleeves.—D.

Engine for Lathes.—F. P. (*Andover*).—A gas-engine is cheaper than any other form of motor, because there is no expense beyond the precise amount required for actual driving. It occupies least room, there being no boiler. Much depends on what opportunity you have for getting cheap gas; the best plan is to obtain prices of steam and gas-engines from different makers, and then estimate the relative cost. Crossley's, Manchester, are the best gas-engine makers; Hindley of Bourton, Dorsetshire, makes small cheap steam-engines.—J.

Paddles for Model Steamer.—T. H. B. J. (*Wesham*).—For a 4 ft. model, the diameter of the paddle-wheels should be about 9 in., but the exact dimensions, of course, will depend on your water-line. You should, if you have a high water-line, make the wheels smaller, or they will overpower your engines. It is much better to err on the side of having them too small than otherwise. A good size for the floats is 2 in. by ⅞ in.—G. J. E.

Overgraining Oak.—T. B. (*Northampton*).—With respect to putting in dark veins upon "maiden oak," I have made little if any reference thereto in the series on graining, because such markings are very scarce in real oak, and if imitated they do not conduce to natural and woody effect. The ordinary plan is of painting them in with vandyke in water, using a veining fitch after the work is shaded and softened. Those workers who use dark veins generally put them on rails or stiles. The most natural effect is got by wiping some of the colour out along the middle of the veins; we get transparency thereby and less "paintiness." Soften with the badger across the veins. Sometimes oak is shaded in oil glaze, and in such cases the same is used for the veins; but water-colour is the most convenient and quickest. The graining roller—viz., for dark pores—can be used either with oil or water-colour. If the latter, it is worked with a little vandyke after all other shading is done. Best burnt umber rubbed up with a little terebine is used for working it in oil. There is no reason why, with practice, you should not get perfect rolling.—DECORATOR.

A "Backlined" Drawing—NEMO—is one in which in order to show without shading all projections, the left-hand side and top lines are thin, whilst the right-hand and bottom lines of each part are drawn in rather thick and black. Mechanical drawings are always supposed to be shaded, as if the light fell at an angle of 45° from top left-hand corner; and every line opposite to the light, *i.e.*, on which no light falls, is *backlined* in unshaded drawings to express what shading would otherwise do.—J. W. H.

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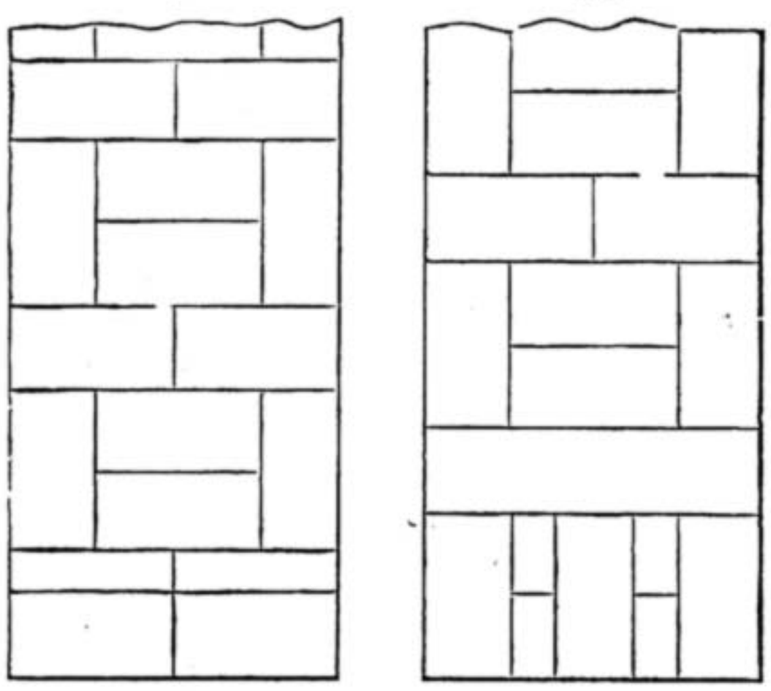
Elementary Examinations.—Answers to questions appearing on page 404, Vol. II, in the "Elementary Examination on Build ing Construction for 1890."

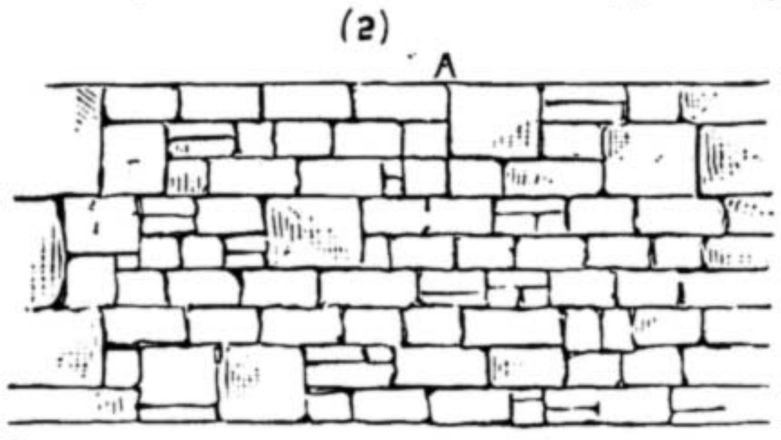
1. Plan of two courses of an 18-in. wall built in Flemish bond, showing the proper arrangement of the bricks in the two courses.

(1)



2. Elevation of part of a stone wall built of squared rubble worked up to courses. In this class of work vertical joints are sometimes allowed, providing

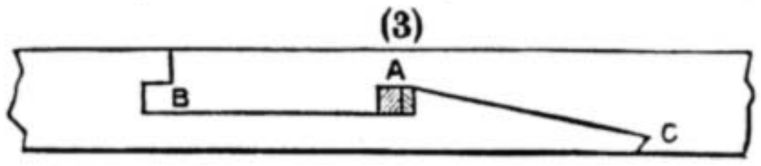
(2)



they are not more than the height of a course in work built in courses as at A.

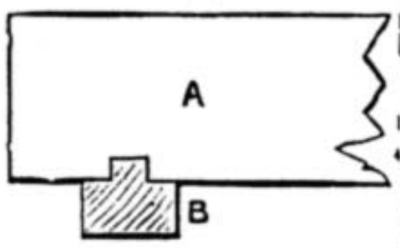
3. Elevation of two 13-in. square balks of timber

(3)



scarfed together, and secured with hard wood wedges at A. These wedges are drawn rather out of proportion for the sake of clearness. The scarf B is used to resist compression, and the one at C to resist tension.

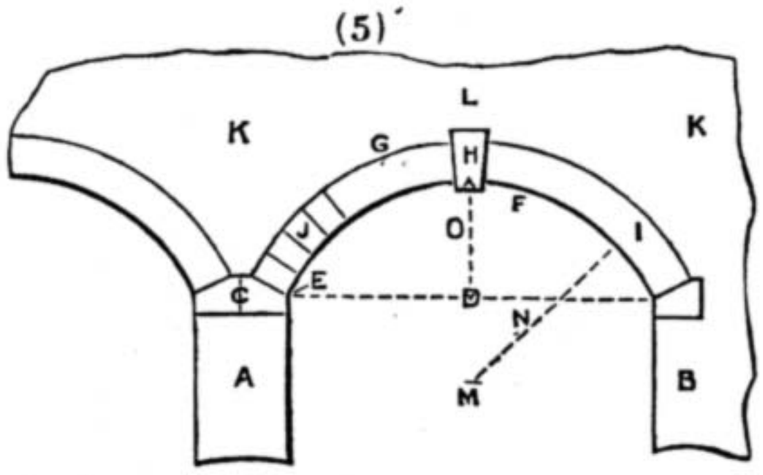
(4)



4. Section of a beam cogged on to a wall-plate. A is the beam that is notched, and B is the plate having the cog left on.

5. Elevation of a stone arch, giving the points of all the different parts of the structure.

(5)

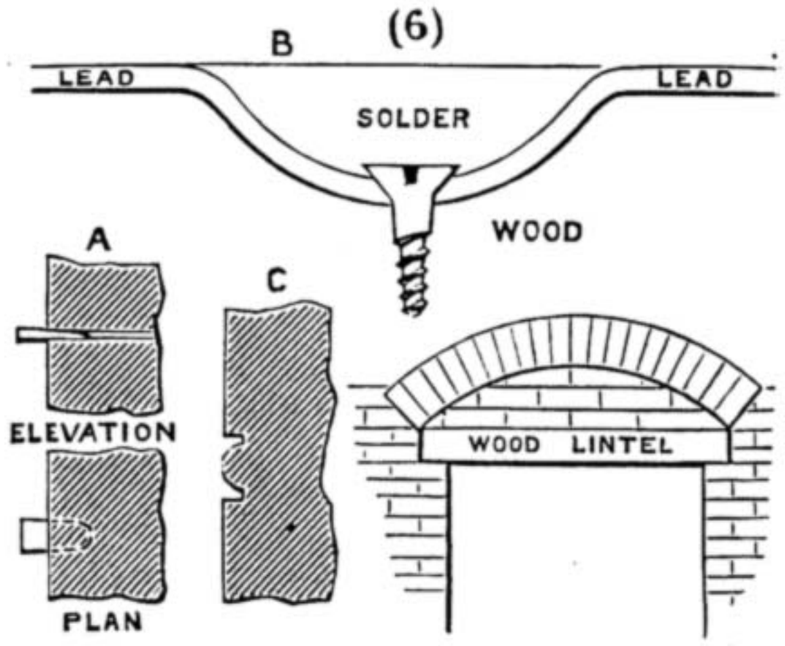


6. The wood plug as shown is the form generally used for fixing woodwork to brickwork when no provision has been made in building the wall. Lead dots are used where it is found necessary to screw the lead to woodwork. The woodwork having been previously hollowed out, the lead is dressed into the hollow and then screwed down sometimes with two screws in each dot slanting in opposite directions, and then filled with solder to protect the screws and cover the hole made by them, likewise to bring the whole to a fair level. The form of bead known as double quirk is more often used in plastering to indicate the skirting and dado when it is necessary to have no projections. In fixing a wood lintel, a rough relieving arch is generally turned over it to protect it from the weight of wall above, but the arch must abut on the wall, and not rest on the lintel.

7. Elevation of a queen-post truss, the iron straps at A being secured by means of iron wedges, etc., called gibs and cotters, at B by means of nuts and bolts, and at C by coach screws.

8. Plan of part of an 18-in. brick wall built in English bond, showing the arrangement of the bricks in one course. B is a vertical section of the above through A A with the footings.

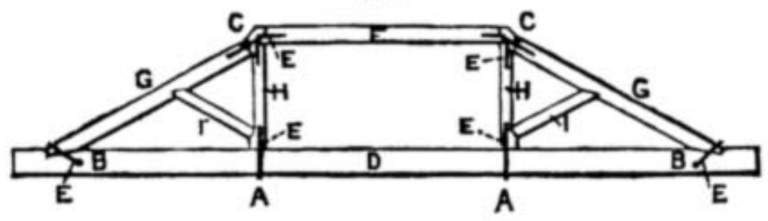
(6)



9. Section of a cast-iron cantilever, the upper flange of which, being in tension, is the larger.

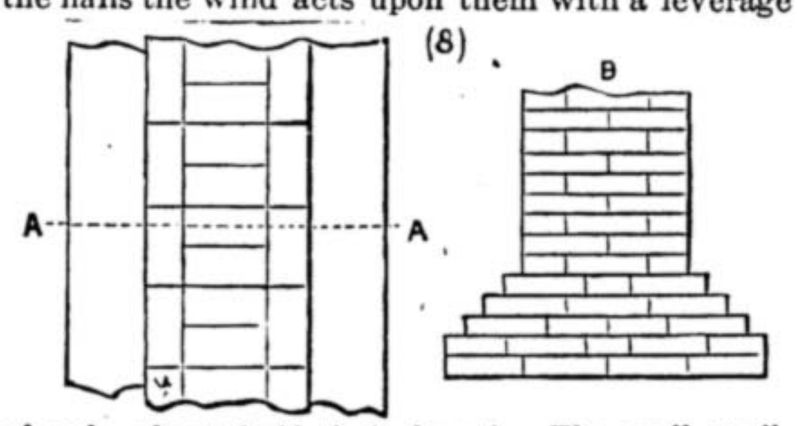
10. Elevation and vertical section of a four-panelled door, showing the top panels, bead, and butt, and the bottom panels, bead, and flush.

(7)



11. Section through the eaves of a roof, showing slates centre-nailed to a 4-in. lap. This is a good way of laying large slates, as from the position of the nails the wind acts upon them with a leverage

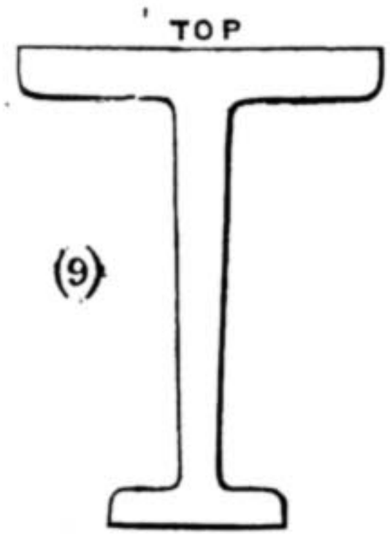
(8)



of only about half their length. The wall, wall-plate, gutter, etc., are omitted.

12. Elevation of part of an iron roof truss, consisting of T iron principals, two angle iron struts, and five tension rods.

(9)



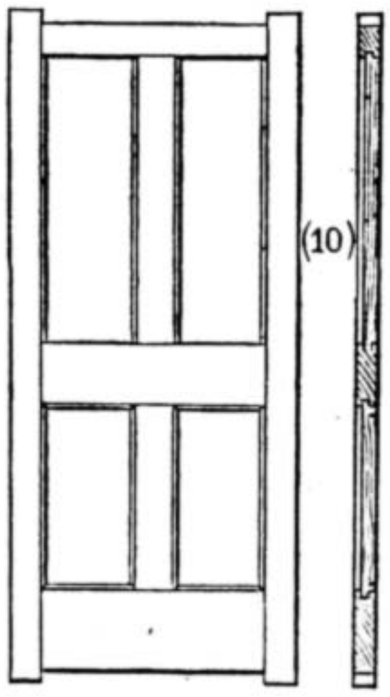
13. Section through an 8-in. lead gutter with step flashings formed at the end of a boarded and slated roof butted against the brick wall of another building. B shows the step flashing in elevation.

14. Vertical section through the foot of a wooden king-post, showing the details of a stirrup iron properly wedged up with gibs and cotters. This is the strap A mentioned in answer No. 7.

In consequence of the great pressure upon the "Shop" columns of WORK, I have been as brief as possible in my answers to the above question.

ANSWERS TO QUESTIONS IN THE SECOND OR ADVANCED EXAMINATION.

(10)

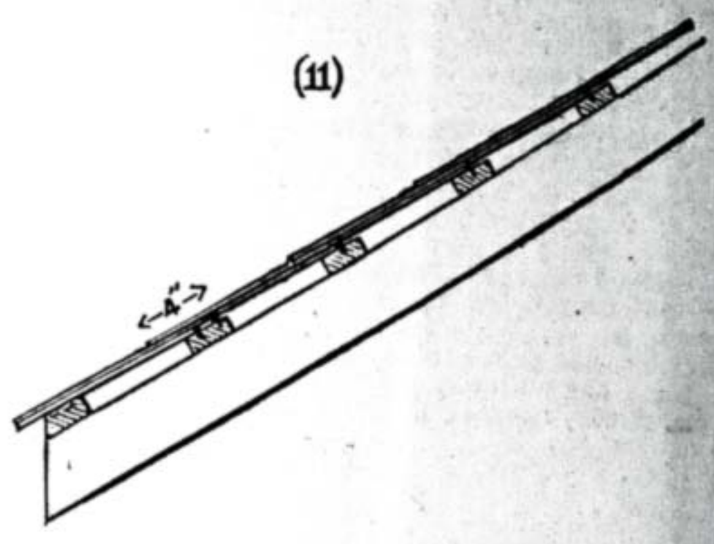


15. Single laths are about $\frac{3}{16}$ in. thick, and double laths are about $\frac{3}{8}$ in. thick. The first coat of plaster generally consists of clean sand, lime, and ox-hair.

16. In mid-summer or mid-winter in temperate climates, or during the dry season in tropical ones, because the sap is then at rest. For joiners' work in England.

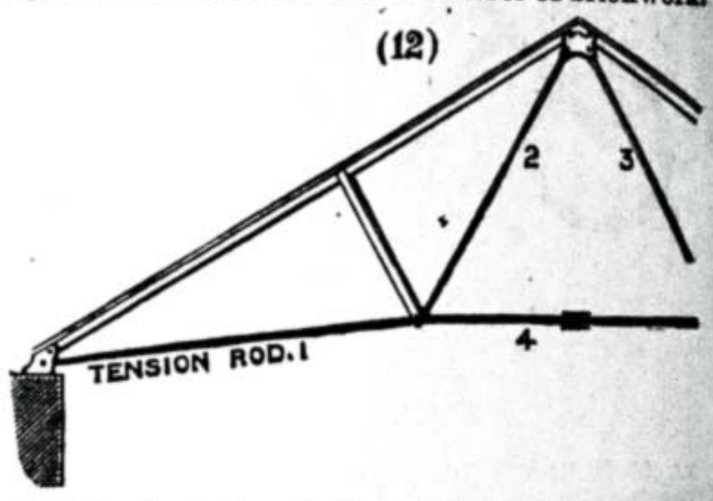
17. The joint A is known as tuck pointing. This makes a very effective joint as far as appearance goes, but it is open to the objections that the projecting ledge catches the weather and gets saturated, and is easily destroyed by frost; also that it lends itself so readily to the deception of making inferior work appear as if it had been done properly. The joint B is known as a struck joint, and if properly made is a very good plain joint, as the sloping surface throws off the wet; but care should be taken that it is not struck the wrong way, or too far in along the bottom edge so as to form a ledge to catch the wet.

(11)



18. In building brick walls faced with ashlar, care should be taken that the stones are of a height equal to an exact number of courses of brickwork.

(12)



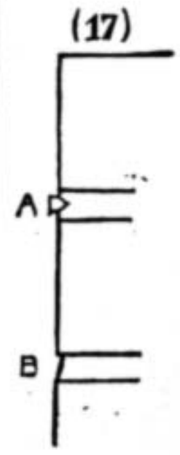
19. The facia board A is fixed to the ends of rafters, and supports the gutter. The soffit boarding B is for the purpose of making good the openings between the under side of the rafters which project

(14)

(13)

beyond the external wall. The dragging tie C is for the purpose of sizing the wall-plates together, and distributing the thrust of the hip rafter. The flitch D is an iron plate put between two wooden girders, and the whole screwed together. The sketch marked E is what is termed a torus moulded skirting.

(17)



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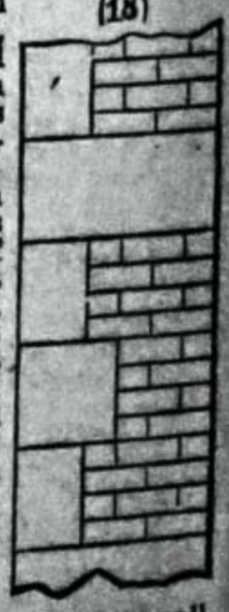

20. The elevation and section A and B give an illustration of what is known as a wiped joint, so called because the solder is wiped round, as it were, with small pieces of greased cloth when it is in a plastic condition. The elevation and section C D give an illustration of a blown joint, so called because the solder is blown round when in a molten state by means of a blowpipe.

21. The section on page 685 shows a hollow wall, with the hollow space next the outer face. The letters A A show the wall ties, which in this case are of iron, and bent in the middle to stop the passage of water along its surface. B B is the proper position for the damp-proof course.

22. The plan on page 685 is called an Open Newel stair. A, A, are the newels; B, the handrails; C, the winders; D, the fliers; E, landings; F, the walls surrounding the staircase; the arrow indicates the

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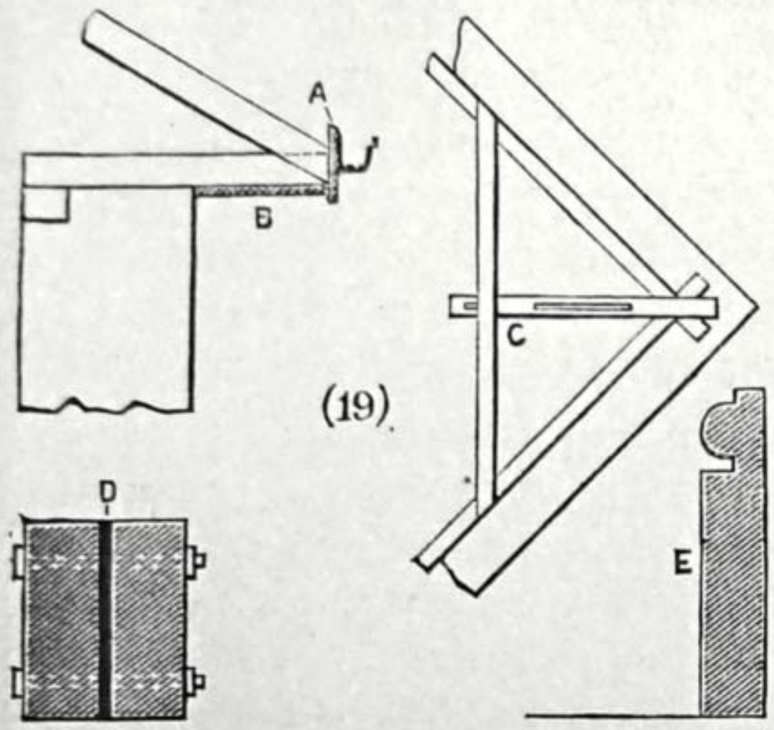
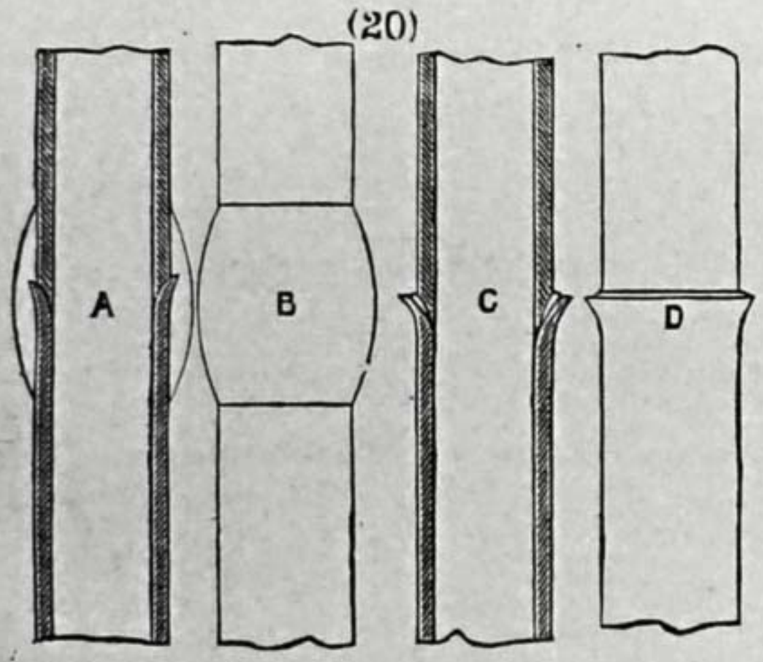
direction of ascent. The elevation at G shows the ends of two steps, with return moulded nosings and a sunk and moulded string.



(19)

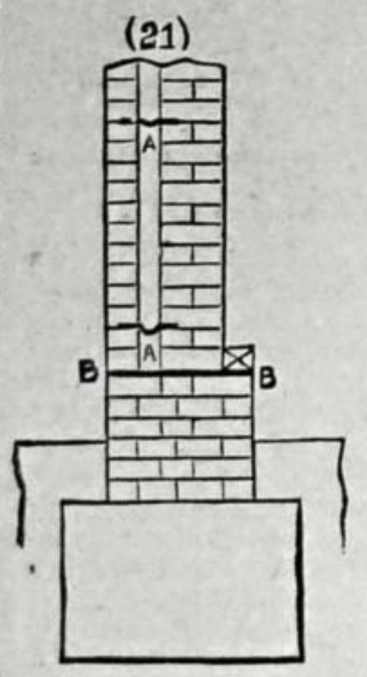
23. Elevation of an iron roof truss, the members being indicated by lines; the single ones show which are in tension, and the double ones those in compression.

(20)



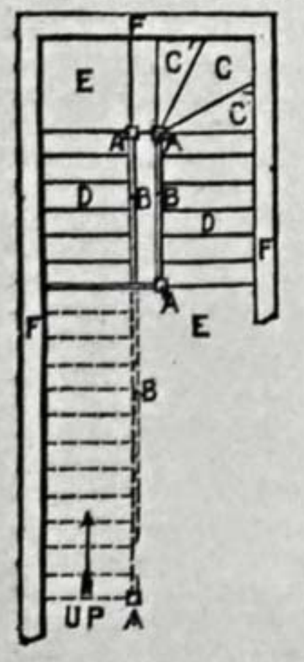
24. End elevation of a traveller running on a gantry. A, A, are the ends of the beams, the elevation of one of them being given in the question; B, B, are the wheels attached to the traveller, one of which is usually toothed or cogged, and connected to the crab or hoist for the purpose of moving the traveller along the gantry, resting on the iron rail C. The letters D indicate the different parts of the gantry, drawn somewhat out of proportion for the purpose of making the whole more plain.

(21)



25. Section through a double cover riveted joint in a ¾-in. tie bar, called chain riveting, showing the rivets with snap heads at A, and pan heads at B, the centre plate C being the tie bar proper, and D, D, the cover plates. These are rather thicker than they need be, but it is a fault on the right side.

26. Vertical section through a window back, showing a coursed rubble wall 12 in. thick, with both



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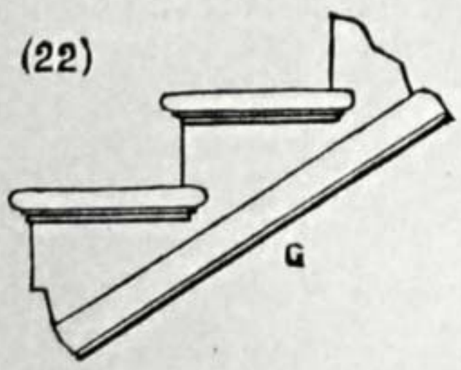
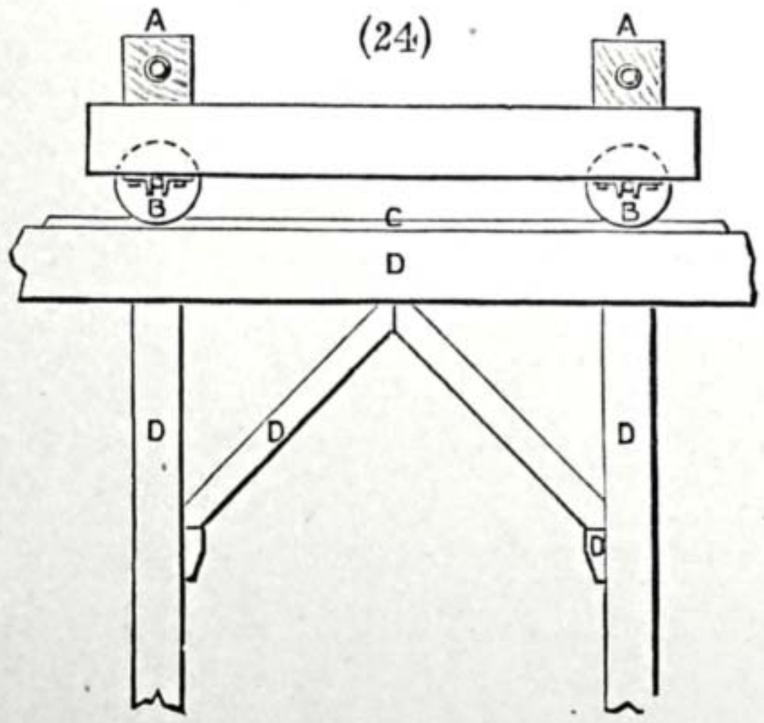


stone and wood sills, bottom rail of a 2¼-in. double-hung sash, and vertical sliding shutters in two 3 ft. 6 in. leaves. The names of the different parts are as follows:—A, bottom rail of front sash; B, wood sill; C, stone sill; D, flap to cover sashes when not in use; E, top rail of apron lining; F, top rails of shutters; G, bottom rail of apron lining; H, skirting;

(23)

(24)



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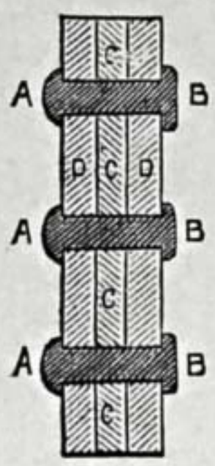

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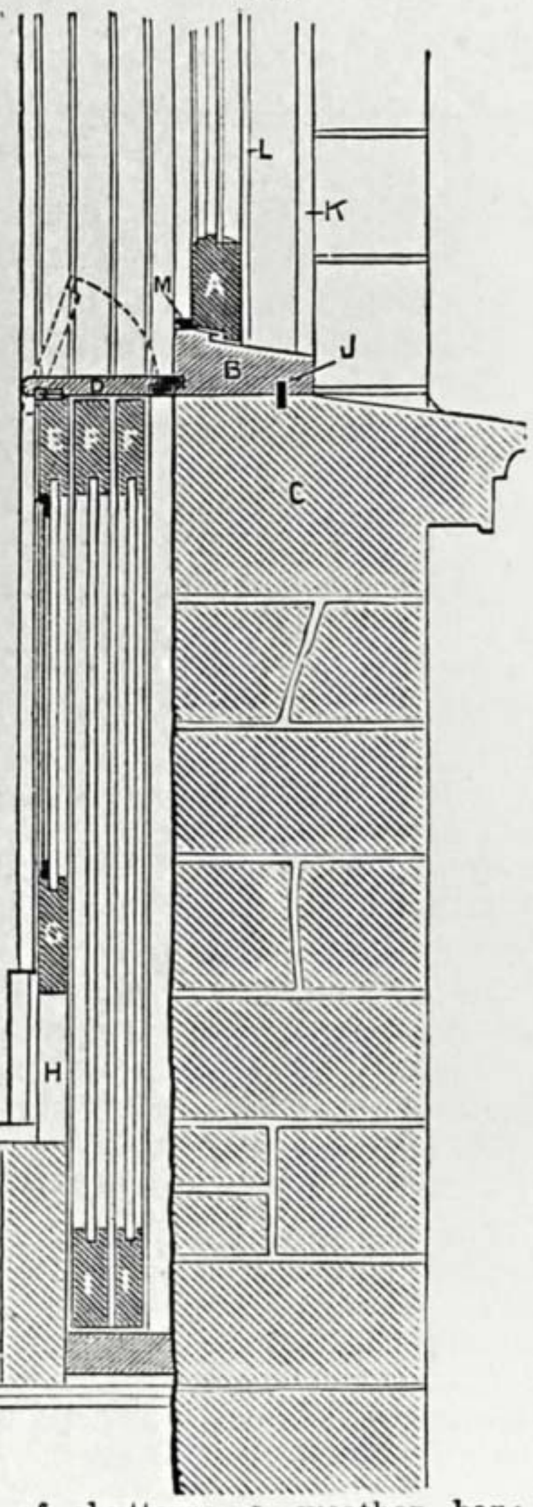

I, bottom rails of shutters; J, weather bar; K, outside lining of sash frame; L, parting bead; M, sash bead.—E. D.

Patents—Provisional Protection.—INDEX.—I am of opinion that any person acting with ordinary caution may virtually be safe in "using and publishing his invention," whilst provisionally protected only; but INDEX must remember that in granting provisional protection, the Patent Office does not undertake to secure the inventor from infringement; it merely confers the power to "use and publish" without prejudice to his patent-rights. Legal and absolute security is only to be obtained by the complete patent.—C. C. C.

Wax Moulds for Plaster.—R. O. (*Sheffield*).—The wax for this purpose such as one gets from ends of wax candles does very well. So does ordinary modelling wax. Were I about to use new beeswax, I should add some tallow and a little Venice turpentine. I scarcely understand R. O.'s query as to polishing casts. Does he mean waxing them? If so, the plan is, after the cast has become thoroughly dry, to heat it and lay it in a bath of melted white wax; when the wax rises to the upper parts of the cast, it may be removed, as saturation will then be completed.—M. M.

Upholstery.—J. L. (*Guernsey*).—You will probably find a suitable work in the following list:—"Art Furniture," by W. Watt, price 6s.; "Chippendale's Gentlemen and Cabinet-Maker's Director," price from £7 to £18 18s.; "Household Furniture and Interior Decoration," T. Hope, 18s.; "Original Sketches for Art Furniture," A. Junquet, 22s.; "Pattern Book for Cabinet-Makers," price 22s.; "La Tenture Moderne," Prignot, tinted plates, 20s.; "Cabinet-Maker and Upholsterer's Drawing Book," Sheraton, £6 10s. to £10 10s.; "Practical Illustrations of Upholstery Work," A. Standage, price 14s. 6d.; "Talbert's Examples of Ancient and Modern Furniture," price 28s.; "Upholsterer's Pattern Book," 6s.; "The Decorative Furniture in the National Collections of France," E. Williamson, £9, These can be had from Messrs. Batsford, 52, High Holborn, London. If these are not suitable, if you write to Messrs. Batsford enclosing stamp and stating exactly what you require, they will most likely be able to supply you, as they deal in both new and second-hand books.—M.

Work on Blacksmithing.—G. H. T. (*Ilfracombe*).—Blacksmithing is contained in "Knight's Mechanical Manipulation," price 18s., published by Spon & Co., 125, Strand, London. I know of no other work on the subject.—K.

Paraffin Lamps.—FRANKLIN.—The "Paraffin Lamp" papers will be continued ere you read this. The other subject you refer to will probably form a feature of Volume III. The question of space in "Shop" replies is already receiving stringent remedial treatment, but time must elapse to derive full benefit.

Lathe.—F. A. (*Portsmouth*).—You have made a good beginning by screwing iron bars down upon a teak bed. You want to complete the lathe yourself and do not like wooden heads. I advise you to buy iron castings, fit them upon your bed, and bore them out with a boring bar. Then as you can get brass castings, get some bushes cast for the mandrel to run in. You do not say whether you have access to a lathe. It is possible to make a lathe without a lathe, by turning the mandrel, etc., on dead centres; but I must not enter upon that here. Possibly it would cost you no more to buy a pair of "heads" second-hand, than to buy the materials to make them of, and the tools to work with.—F. A. M.

Rollers.—J. W. M. (*S. Shields*).—The rollers for wringing, mangling, or washing machines, are not in everyday request. Mr. McCrerie, of Henry Street, St. John's Wood, N.W., is a wood turner who advertises to supply them, but it would be better for J. W. M. to apply to Bradford, of Holborn, or Harper Twelvetrees, of City Road, both of London, than to buy wood and send to a local turner, which I fear is the only alternative. A great deal depends on how many such rollers J. W. M. requires, and he does not state that. If he elects to have the rollers turned to order by a local turner, he will find sycamore will do well, but it must be well seasoned.—B. A. B.

Litter.—JACK.—This subject will receive attention in due course.

Picture-Frame Making Book.—NOVICE.—Get "Picture-Frame Making for Amateurs," 1s.; Gill, 170, Strand, London.—K.

Waterproofing.—W. J. (*Elgin*).—See reply to J. R. (*Newton*) at page 505 of WORK, No. 83, Vol. II., under head of "Waterproofing." The results obtained by W. J. are another confirmation of the truth of what we told J. R., and is the result which must inevitably attend the use of all unsuitable materials or combinations of the same for the purpose to which W. J. applied it. It was used by the late Colonel Maceroni, who was the inventor, for his boots and shoes, especially when on the sea coast, and we used it with success under similar conditions.—C. E.

Gold Paper.—J. M. (*Bacup*).—The gold paper is bought in sheets ready gilded; many mount cutters, etc., supply it ready prepared for use. If, however, you have your sheet of gold paper, pin it down securely with drawing pins upon your bench with a sheet of tissue paper under it, prepare a pot of good clear glue, and strain through a piece of muslin, so that no grit of any kind is therein; with a clean brush glue carefully back of paper, with care that you do not miss any part; let it dry thoroughly, then cut in narrow strips to width of bevel; the usual six sheet mounts require it cut $\frac{3}{16}$ in. Take your mount, lay face uppermost upon your bench, cut the left end of gold paper mitre shape, and moisten as you would a postage stamp; lay it evenly upon the bevel, and rub well down with a cloth; turn mount over, and turn edge under, rubbing well down, and so continue until your mount is complete. The cutting makes a glassy bevel, and the above sticks very easily.—G. C. R.

Mirror Painting.—R. T. E. (*London*).—It would be better and cheaper for you to buy the medium mentioned by me (Vol. II., page 553) for use in mirror painting in large quantities from the manufacturer than to waste money in experimenting, to say nothing of the risk attaching to the manufacture of any kind of spirit mediums and varnishes at home, because I do not know how far you may be equipped with the necessary apparatus. If you are an amateur, I advise you more urgently still not to make your medium yourself.—H. J. L. J. M.

Grinding Razors.—W. H. R. (*Liverpool*) writes as to this. He should advertise in our "Sale and Exchange" column.

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III.—QUESTIONS SUBMITTED TO CORRESPONDENTS.

Draughtsmanship.—NEMO writes:—"Can anyone recommend me a good book on draughtsmanship?"

Heating Greenhouse with Paraffin Oil.—J. F. (*St. Day*) writes:—"Will any brother horticulturist tell me how I can heat my small greenhouse, 15 ft. by 6 ft., with a paraffin stove, burning paraffin oil? The great objection to utilising paraffin is its very disagreeable smell, and I am afraid it will injure my plants. I can get abundance of heat, but how can I get rid of the smell?"

Heating Tools.—A. T. M. (*Lichfield*) asks as to "the best way to heat bookbinders' finishing tools without the aid of a gas-stove, as we have not gas here."—[Some reader, no doubt, will enlighten A. T. M. In the meanwhile, possibly the ordinary fire or an oil-stove might be brought into requisition.]

Cedar Pencils.—CEDAR writes:—"I should like to know if there is any way of treating pencil cedar so as to render it tougher, and not so liable to split; when worked down thin, it is very brittle; my pieces are quite small, the largest not more than ⅜ in. diameter. Can this be done by steeping the wood in any liquid? If this discolours the wood it is no great objection, although better if it did not."

Points and Crossings.—W. G. (*E. Dereham*) writes:—"Will some reader kindly give me information on points and crossings? What I want to know is how to mark out the bends of point, and splay of the crossing ready for the planing machine, 4 ft. 8½ in. gauge. Or thus, the leads of the crossings and angles:—1 in 4, 1 in 6, 1 in 7, 1 in 8, 1 in 9, 1 in 10."

Patent.—G. L. S. (*Darlington*) writes:—"Can any reader of WORK kindly furnish me the name and address of a trustworthy London patent agent?"

Drive Gates.—WOODPECKER writes:—"Will any reader kindly inform me where I can purchase working designs for a pair of 'carriage drive' gates, constructed of wood panels filled in so that they cannot be seen through?"

Preparation for Blackboards.—M. (*Bolton*) writes:—"I should feel gratified if any reader could give me some information as to the making of a preparation for blackboards. I have tried several but they do not act. They leave a rough surface, and the chalk marks are often left on, even after a considerable amount of rubbing with the duster."

Tuning Concertina.—C. I. (*Addingham*) writes:—"Will any reader oblige me with instructions how to tune an Anglo-German concertina with steel reeds, and say if I could purchase steel reeds ready for insertion?"

IV.—QUESTIONS ANSWERED BY CORRESPONDENTS.

Paint for Tickets.—MIEUX QUE ÇA writes, in reply to A. J. S. (*Moseley*) (see page 601, Vol. II.):—"It is not necessary to stone them to obtain this end, unless you desire an extra amount of durability. For black letters with white ground, the following will do admirably. Break up a little white lead, plus a little clean driers, in a little raw linseed-oil and turps to about the consistency of cream, or perhaps a little rounder, as tin is apt to grin a good deal through white. Strain, and then give your tin tickets two coats of this. Now get as much as you require of white zinc and mix up with a nice clear drop of French oil (varnish); strain this through something fine—piece of an old cotton stocking or sock—and do not paint it on, but simply let as much stuff run on to a ticket as you think will flow to all its edges. Hold the article up sideways, now this way, now that way, giving it a little blow from the mouth to help it, and so on. Now make up your black in precisely the same manner as your finishing white, and one coat of this will cover well on your white; but if you require a black ground with a white letter, one coat of black as above flamed on will be quite solid, but your writing will require two coats of white at least."

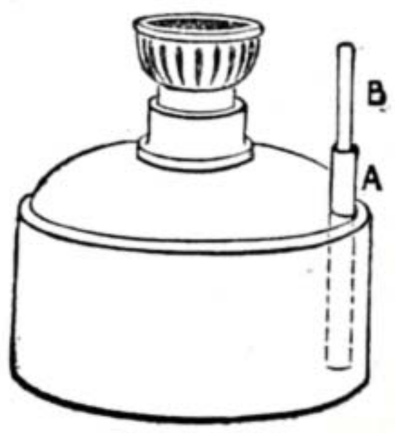
Hanging Paper.—A. M. writes to JACK OF ALL TRADES (see No. 89, page 602): "You may get Japanese leather paper from the original importer of this material, Mr. Robert Christie, 102, George Street, Portman Square, W.; or from another large importer, Messrs. Rottman, Strome & Co., 45, St. Mary's Axe. If he hails from the 'North Countree,' he will find a stock of these papers kept by Messrs. Wylie and Lockhead, 45, Buchanan Street, Glasgow. In hanging, use a stiff mixture of glue and paste; glue itself sets too quickly, and paste alone has not enough 'stickiness,' but when both are mixed a splendid adhesive is formed."

Paint for Tickets.—WORKER BEE writes to A. J. S. (*Moseley*) (see page 601, Vol. II.):—"I have used 'Aspinall's Enamel' with good effect. Doubtless 'Foo-chow' is equally good."

Gilding.—WORKER BEE writes to JACK (see page 602, Vol. II.):—"Had you looked at the Index of Vol. I. of WORK, you would have seen all about it on page 118, and saved your time in the bargain."

Waterproofing.—WORKER BEE writes, in reply to OLD TIPTONIAN (see page 602, Vol. II.):—"Hang up your cart sheet in a shed through which a current of air is playing, and give it two or more coats of boiled linseed-oil, allowing one coat to dry before applying another."

Indicator for Reservoir of Paraffin Lamp.—L. S. L. (*Kirkcaldy*) writes:—"Can any reader suggest a simple method of indicating the depth of oil in a *metal* lamp reservoir? The only way which occurs to me is to have a tube, A, on sketch, reaching to near the bottom of reservoir, in which another tube, B, with closed ends, acts as a float."



Oil Tester.

Bursting Waterpipes.—W. M. R. writes, in reply to GLASGOW (see Vol. II., No. 86, p. 554):—"Try Turnbull, Bishopbriggs, who has a new regulator in hand. The G. C. W. W. is compelling the use of a governor for parties using hoists; cost £4, if I remember correctly."

Camera Fittings.—E. H. (*Dartmouth*) writes, in reply to J. C. (*Glasgow*) (see No. 89, page 602):—"You can obtain all you require from Henry Park, 1, Orchard Buildings, Acton Street, Kingsland Road, London, N.E. Send three stamps for list; price, rack and pinion for ½ in. plate, about 6s."

V.—BRIEF ACKNOWLEDGMENTS.

Questions have been received from the following correspondents, and answers only await space in SHOP, upon which there is great pressure:—A. B. (*Kirkcaldy*); W. O. (*Liverpool*); METAL WORKER; J. H. (*Drybrook*); E. H. H. (*Chatham*); CONSTANT READER; E. M. A. (*Salisbury*); PATIENCE; J. P. (*Birkenhead*); L. G. (*Bradford*); J. H. (*Leicester*); W. M. (*Hereford*); C. E. H. (*Horwich*); L. P. (*Colchester*); P. M. M. (*Glasgow*); A. A. W. (*Leicester*); G. M. (*Romiley*); W. A. T. (*No Address*); F. S. (*Normanton*); ALONGOA; C. B. F. (*Seacombe*); F. C. (*Leytonstone*); NORTHERNER; YORKSHIREMAN; IGNORAMUS; W. E. D. (*Hull*); W. H. M. (*Preston*); W. A. Y. (*Cambridge*); J. N. (*York*); F. E. G. (*Norwich*).

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Tools, Tools, Tools.—The cheapest house in the trade for English and American tools is LUNT'S, 297, Hackney Road, London, E. Send stamp for reduced price list. [8 R

Tools! Tools!! List, stamp. Cheapest in the trade.—STIFFIN & CO., 324, Essex Road, London, N. [2 S

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Patent Work.—Specifications drafted, 10s. 6d. per foolscap sheet; drawings, 21s.; duplicates, one-third. Twenty years' experience.—J. MANGNALL, Harpurhey, Manchester. [2 S

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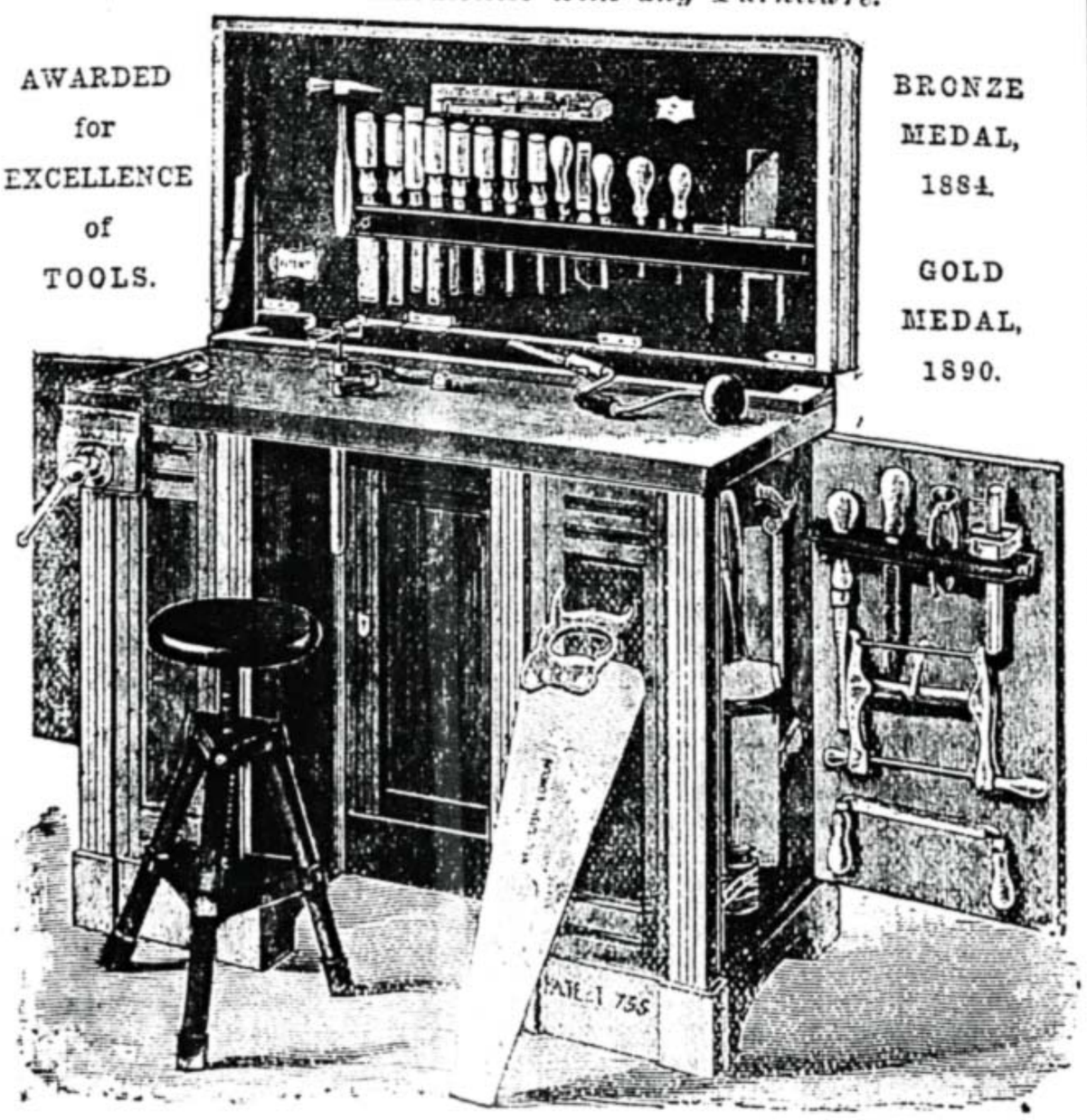

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